THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT No. 45 BROADWAY, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART, ... Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid..............$3 00
Single copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery venue, San Francisco Cal., is the authorized Western Agent for the JOURNAL.

MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

NEW YORK, JUNE, 1887.

THE office of the RAILROAD AND ENGINEERING JOURNAL is now at No. 45 Broadway, New York, having been removed from No. 23 Murray Street on May 1. All communications for the JOURNAL, its proprietor or its editors should be addressed to No. 45 Broadway, New York.

IN this country of frequent changes it is a fact, we think, worthy of note, that the card of Fuller Brothers & Co., which will be found in another column, is the renewal of an advertisement which first appeared in the JOURNAL some 35 years ago; and that the address of the address of the firm was the same then as now—an almost unprecedented occurrence in New York.

THE American Society of Mechanical Engineers presents a varied and interesting programme for its spring meeting at Washington, which begins just as this number of the JOURNAL is issued. The subjects of several of the papers promised for the meeting are of importance, and the number of the papers shows no lack of interest in the Society on the part of its members.

THE use of steam at a high pressure and of the triple-expansion engine seems to have become established as the latest practice in marine engineering. Some are disposed to go still further, for a new steamer in England is provided with quadruple-expansion engines. This is an experiment, however; but the triple-expansion engines have so far shown very good results, both in economy and ease of working.

Probably the next advance in marine construction will be in the use of twin screws, which have already been applied in a number of war-ships, but have not come into general use. Twin screws are not a new device by any means, and were successfully used many years ago; they are strongly advocated by Commander Chadwick in a recent article in *Scribner's Magazine*.

An excellent example of a triple-expansion marine engine of American design and construction will be found on another page. It is for use on a steamer on the great lakes, where so much of our best marine construction is to be found.

THE brake trials at Burlington are in successful progress, but are not yet sufficiently advanced to give definite results, and the publication of a mere list of stops hardly seems worth the space which it would occupy.

All parties seem to have profited by the experience gained in last year's tests, and several improvements have been made. The most notable of these is the use of electric apparatus for the purpose of securing the almost simultaneous setting of the brakes throughout a train, thus avoiding the delay necessary for the passage of the air through the brake-pipes, which is sufficient to cause severe shocks in a long train. There are minor improvements which increase the efficiency of the different brakes, and perceptible progress has been made.

THE proposed lease of the Boston & Lowell Railroad to the Boston & Maine Company is a step in advance in the process of consolidation of New-England railroads, which has been going on for some years past. In the beginning all railroad companies were small, each controlling a few miles of road only; a few, that is, in comparison with the great companies of to-day. In New England this small company system was closely and jealously adhered to until a few years ago; so closely in fact, that a legislative enactment, passed after a long struggle, was required to force the Boston & Worcester into the consolidation with the Western Company, by which the Boston & Albany Company was formed. Even after time had showed the beneficial results of this consolidation, but little change was made in this direction for some years, although the Old Colony absorbed some of its extensions, and finally completed its system by the purchase of the Boston, Clinton & Fitchburg tangle of short roads. The Eastern Railroad attempted a career of extension, but its disastrous failure followed a too hasty and reckless expansion. Recently, however, a new era of consolidation has begun; the Boston & Maine absorbed the Eastern; the Boston & Lowell took in its northern connecting lines in New Hampshire, and the Fitchburg completed, by consolidation, its line from Boston to the Hudson River through the Hoosac Tunnel.

Now, arrangements have been made by which the Boston & Maine is to lease the Boston & Lowell, thus becoming the largest and most important corporation in New England, and practically controlling all the lines from Boston to Northern New England and Canada. The Boston & Providence, it is also said, is to be absorbed by the Old Colony, and made a part of that system. The Boston lines will then be controlled by four strong companies, leaving out only the New York & New England, which is probably still in the market, and which, it is not unlikely, will before long become an appendage of some wealthier corporation.

WHATEVER may be said of the small company system—and from one point of view there are many arguments in favor of it—it is not generally conducive to the best management. The small company is very apt to be controlled by small men, and, even if it is fairly successful financially it is usually very slow to make changes

and to introduce improvements. Thus, while the average returns from the New England roads have been better than from those in any other part of the country, many of them—and not all of them the poorest—are much behind the Western lines in their appliances and methods, and do not show signs of improvement. Consolidation has not always remedied this, for too often the policy which has grown up under the small company has survived the extension. But with this extension there come at least the means and opportunity of doing better, while the younger men, who are growing up to replace the old managers, have the advantage of training in a better school and with a wider range of view.

THE best attainable authority on the subject gives the length of track laid on new railroad lines in the United States for the four months of the current year to the end of April at 1,564 miles. More than one-half of this was in the Southwest—Kansas, Colorado, the Indian Territory and Texas. A considerable part of the remaining half was in the Southern States. As in January, February and the greater part of March the weather was very unfavorable for track-laying in the North and Northwest, those sections were hardly able to contribute their fair share and may be expected to show an increased mileage later in the year.

In view of this fact, and considering the amount of preliminary work on new lines which has been already done, the new mileage of the present year may be expected to reach a high figure, and the estimate made by our contemporary, the *Railway Age*—10,000 miles for the year, with a possible excess over that figure—does not seem an extravagant one. There are several long lines now well under way, and with such financial backing that there is every probability of their completion, while more than the usual number of branch lines and feeders have been undertaken by responsible corporations.

It is to be regretted that so much of the new mileage, completed and under construction, is of parallel and competing lines, built, not so much to develop new country or serve a growing traffic, as to divide existing business and secure it for certain main lines. Much of the money expended in this direction is absolutely sunk and is of no use, except so far as it may be said to protect existing investments. Under more judicious systems of management much of it might be reserved for investment where it is really needed.

THE annual statement of the American Iron & Steel Association for 1886 covers one of the best years the iron trade has ever had in this country. The production of pig-iron was the largest on record, while the steel production also exceeded that of any previous year. The manufacture of rolled iron, though greater than in 1885, was exceeded in several previous years; a fact which is accounted for by the increasing use of steel for many purposes. The iron rail manufacture, for instance, has entirely ceased, and steel is rapidly superseding iron for the making of nails.

While the year was a prosperous one so as far as the demand and the amount of production was concerned, there was not such an increase in prices as might have been expected. Pig-iron, rolled-iron and other standard products, for instance, showed only a very small advance over the lowest prices prevailing during the period of depression. The only notable increase was in steel rails, which showed a heavy advance under the influence of a special demand and a necessarily restricted production.

THE board of managers of the Association of Engineering Societies, at its last meeting, adopted an address to the local societies and clubs of Engineers, suggesting the formation of a national society or union, in which all shall be represented. The present Association, which includes seven societies, exists for the purpose of publishing a journal of their proceedings only, and has very limited powers. To enlarge these, and secure joint action on other matters, is the object of the present movement, which is not the first attempt of a similar kind. The address calls a Convention of Societies to arrange the proposed union.

WE are informed that the Pennsylvania Railroad Company intends to make exhaustive trials on its line of a compound locomotive on the Webb system. The trial, it is said, will be made with a London & Northwestern locomotive built under Mr. Webb's own supervision, which will be brought over for the purpose. This will be the first really thorough test of the compound system in this country, and its result will be watched with much interest.

THE discussions at the railroad clubs during the past month have been chiefly on the revision of the rules for interchange of cars. As these rules have now been submitted to a pretty thorough discussion in the different sections represented in the clubs at Boston, New York, Buffalo and Chicago, members ought to be able to consider them intelligently at the Master Car Builders' Convention, and to decide quickly on whatever changes or amendments may be required.

RAILROAD officers and editors of technical journals have for some time felt inclined to believe that every white male citizen of the United States had felt it his duty to invent a car coupler. A new terror is now added to life by the statement (in a reliable daily paper) that a woman—and a colored woman at that—has invented a coupler "which promises to supersede all others," as all of them have done for so many years past.

COMBUSTION.

IF the books, papers and articles which have been written on this subject were collected together they would make quite a library by themselves. Nevertheless, there is no theory of combustion that is entirely satisfactory, and practically the grimy firemen seem to know more about it than the scientific people do. A very good story is told of an invention for improving combustion in locomotives, which was tried on a New-England railroad some years ago. It consisted of some elaborate arrangement of pipes for admitting air at the front of the engine and conveying it to the fire-box. A trial trip was made with invited guests, champagne, etc., etc. The engine did not make steam freely and failed to make time, arriving at its destination a half hour or more late. While the guests were firing up with liquid fuel, the inventor of the device went unobserved to the locomotive runner, and holding up a seductive twenty-dollar bill, told him that if on

the return trip he would make time the bill would be his. The invento·then joined his guests and explained to them that the reason his invention had failed so far, was because the pipes required "adjusting." At the same time the locomotive runner, unobserved, went to the front end and stopped up both the pipes which scooped in the air, turned his engine around, and on the down trip made up all the time lost in coming up. He was then congratulated by the inventor, who handed him the coveted twenty-dollar bill. When this was securely deposited in the trouser's pocket of the engineer he told the inventor, "yes, we got here all right, but it's because I stopped up them pipes."

In 1858 an "Elementary Treatise on the Combustion of Coal and the Prevention of Smoke," by C. Wye Williams was published in the "Weale Series." In that book he explained the need of introducing a supply of fresh air above the fire, in order to produce perfect combustion. The result was that a great variety of plans were devised and adopted, for admitting air above the fire in locomotive and other boilers, some of which are now in use, but a fireman discovered that by putting an inverted scoop-shovel in the opening of the furnace-door he could prevent or diminish the quantity of smoke produced. After numberless inventions have been tried, with the exception of the brick-arch, that of the ignorant fireman in the form of a deflector is about the only one which has survived and is now used to any considerable extent.

Leading questions, relating to the most economical rate of combustion, the proportion of grates and fire-boxes, are still in dispute, and the most opposite opinions are held with reference thereto by well-informed persons. Thus some engineers hold that slow combustion is the most economical; whereas, others aim at producing intensity of heat, that is to burn the greatest possible quantity of fuel within a restricted space. Some hold that the larger the grate the better, others that the smaller it is, provided a sufficient amount of fuel can be burned in it, the greater the economy. Some advocate the use of small grates and fire-boxes; others small grates and large fire-boxes. Deep and shallow fire-boxes, both have their advocates, and it may be said that hardly any principle relating to the proportions of fire-boxes and grates for locomotives is settled beyond question. This leads to the suspicion that perhaps the proportion of grates and fire-boxes is not a matter of great importance. At any rate it is not likely that any very definite conclusions can be reached from purely theoretical considerations, although it seems very probable that an exhaustive series of experiments, made by a competent person to determine the most economical proportions and forms of locomotive boilers, might involve information which would be of very great practical importance. Perhaps in the future some one or more railroad managers may recognize the value of that kind of knowledge, and have the experiments made which are needed to teach us what form and proportion of locomotive fire-boxes are the most economical. In the meanwhile we will be obliged to feel our way as best we can.

In discussing combustion, the text-books generally treat of its chemistry alone, and tell us how much oxygen must be supplied for a given quantity of fuel to burn it perfectly. While it is very important to know just the proportions in which carbon and hydrogen unite with oxygen, and that a certain amount of air must be admitted above the fire to burn coal perfectly, yet, notwithstanding all we know of this aspect of the subject, locomotives still smoke about as badly as ever, and no marked amount of economy, such as has resulted from the use of compound marine engines, has been effected in locomotive service and, notwithstanding our knowledge of chemistry, the practical firemen, who are ignorant of all science, generally produce better results than "them literary fellers" can.

Some mechanical engineers build their fire-boxes with many holes in the sides of the fire-boxes to admit air. The firemen plug them up, and find that their engines make steam better then they did with the holes open. The chemist teaches that the production of black smoke is a great waste of fuel. The fireman will tell you that he likes to see it roll out of the chimney, because that shows that "she will do her work.'

The fact is that our knowledge of chemistry has not helped us much in burning fuel. There are some mechanical principles involved in the process, which, to a very great extent, determine whether the chemical combinations which occur during combustion will be complete or not. It is only lately that these have been understood and recognized. Some of them were very clearly explained in a paper read before the Iron and Steel Institute by Mr. Frederick Siemens in 1884, and afterward in a discussion by the same distinguished authority of another paper. His remarks will be quoted at some length, because his explanation of what may be called the mechanical theory of combustion would be certain to lose in clearness if put into other language. In the paper referred to the distinguished author said:

It can be easily shown that when flame is brought into contact with any solid body, it is more or less quenched, according to the substance, size and temperature of the body. A very simple experiment in proof of this, and one which is familiar to most people is the following: Take any ordinary illuminating-gas flame, such, for instance, as a batswing, and place a glass rod or tube into the middle of it; the flame will immediately burn dull, and a large quantity of lamp-black will be deposited on the piece of glass. This action is most marked when the rod is cold, but takes place, though in a less degree, at any temperature, for the reason that the material to be heated is necessarily always at a lower temperature than the flame, also owing to the disturbance in the combustion caused by contact of the solid substance with the flame. I hope shortly to treat this subject more fully from a physical point of view; but the experiments I have made establish the following most important fact, namely, that a good flame, or in other words, perfect combustion, can only take place in an open space or in one of sufficiently large size to allow the gases to burn out of contact with solid material. * * * *

When it is considered that the temperature of the water in a boiler working at 60 lbs. pressure on the square inch is only 311° Fahr., whilst the temperature of gaseous flame may be taken at 4,000° Fahr., it will readily be perceived what a quenching effect the metal of the boiler, which is of course at the temperature of the water, has upon the flames. In this case the principle has been followed of letting the active flame consume itself in the open space of the tube without allowing it to touch the sides until after complete combustion may be brought into direct contact with solid bodies. By such an arrangement, complete and smokeless combustion is obtained, with the result of longer life to the boiler, the sides of which more rapidly deteriorate through direct contact with the flame than from any other cause. As the heat of the flame which is not transmitted by radiation comes after complete combustion into direct contact with the sides or flues of the boiler and its regenerators, it is completely utilized, and a saving of fuel to the extent of 25 per cent. is secured by this method of heating.

The results obtained in actual practice show that there can be no doubt that almost all heating apparatus used in the arts, in which direct contact of flame with the substances treated is not necessary for chemical reasons, will be materially improved by the application to them of the principle of transmitting the heat of flame by radiation only, while the heat of the completely burnt products of combustion is better utilized by contact.

Complete combustion of the fuel is ensured by this method of heating, and it will therefore entirely abolish the smoke nuisance. Smoke is never formed when combustion is complete, being always caused by flame coming into contact with solid bodies, the process of combustion being thereby checked. This is for instance, the reason why brick-kilns generally smoke so abominably, for in them scarcely developed flame is forced to impinge immediately on cold bricks and can therefore only act in a very incomplete and uneconomical way. The author has frequently made the observation with

regard to regenerative furnaces, that a short combustion chamber invariably gives very unsatisfactory results, and accounts for it by the fact that the flame is hardly formed before it has to pass through the outlet ports and into the chequer work of the regenerators, where its combustion is checked and smoke is formed in consequence. To work well, a brick or pottery-kiln should be so built that the flame can burn itself out in a free space before being brought into contact with the bricks or pottery. Zinc-distilling furnaces, and in fact all furnaces in which muffles, tubes, crucibles and other vessels are used, will in the same way be much more economically worked on this new principle. * * * *

There were several ways of saving fuel; one was by good combustion; a second was by increasing the intensity or temperature of the flame; and another was by utilizing the heat of radiation. If the flame was allowed to touch the sides of a boiler, there would naturally be smoke on its inner surfaces, and the radiant heat of the flame not being able to penetrate such an atmosphere of smoke, the boiler could not gain the advantage of it. Hence the necessity not only of perfect combustion in the first instance, but that the flame should be maintained clear and bright. Then, again, as regards the production of a higher temperature in the flame, not only was the radiation increased thereby, but more heat could be abstracted by contact from the products of combustion. There were, therefore, several causes combining, each of which contributed to effect a saving, and 25 per cent. and more could be easily gained if proper arrangements were made. With the boilers which were in use at the author's glass works at Dresden, and at other works in Germany, there was an average saving of 25 per cent. over boilers formerly heated by gas on the non-radiation principle, so that, in comparison with boilers heated by direct flame, he thought there should be a still greater saving. It was necessary, however, to work the boiler continuously, for it was only worked in the daytime and stopped at night. The saving effected by the use of gaseous fuel was not so great. * * * *

He might have commenced by tracing the action within a flame from its beginning to its end, from the moment the gases met until combustion was perfect and even further until the heat had been fully abstracted from the products of combustion. If flame was traced in that way, it would be found to pass through various successive stages materially differing from one another. There were, as he had shown in the paper, two special stages which required quite different development and treatment. The first stage was that of active combustion, the essentially chemical process by which all heat was produced. The second stage was after combustion had been completed, and the products of combustion alone had to be dealt with, which contained the greatest portion of the heat produced during the first stage or that of combustion. Now these two stages were so entirely different that it was quite reasonable that they should be separately and differently treated, and should not be considered as one, as had been invariably done hitherto. It was necessary to treat the flame according to its stage, and it had been one of the objects of his paper to detail that in a practical way. He had stated that in the first stage, that is, in that of chemical action, the flame ought to be allowed free space within which to burn; it should not be interfered with by surfaces of any kind and it should be allowed freely to radiate out its radiant heat. In the second or neutral stage, the products of combustion had very little power of radiation, and as they did not injure surfaces upon which they impinged, they should be brought into contact with the surfaces to be heated for the purpose of abstracting their heat. He need not say any more upon this, because it had been clearly stated in the paper; but what he might speak about was the scientific theory which explained why combustion was interrupted when the flame met with solid surfaces, and why the solid surfaces themselves suffered so much, not from the heat of the flame, but from the action of the flame; and why, further, the flame had such power of radiation in its first stage and so little in its second. These were all questions that could be answered by accepting one or other of the theories of combustion. There had been various theories proposed, but it was agreed in all these theories that the flame or the gases in combustion forming the flame were violently excited, and that the molecules of gas were rotating around one another, or were in motion of some kind. He thought the electric theory had the best chance of being the right one, and he would accept it because it explained all these occurrences. According to the electrical theory, a flame consisted of explosions of lightning very numerous and very minute. In accepting this theory, it was at once evident why a solid body brought into such a flame would obstruct its action, such solid body having the effect of arresting the motion of the gas by attraction and adhesion. Consequently, the gases which were supposed to revolve were obstructed in their motion, and not being able to move, combustion could not continue, at least in those parts nearest to the opposing surfaces. The consequence was that there was less intense heat, and that smoke was produced instead, enveloping the obstructing surfaces; and so radiation could not act, because it could not penetrate the cloud of smoke in which the flame was enveloped. Then, as regarded the action of the flame on any body, it was quite natural to expect that if flame was composed of innumerable flashes of lightning, no body exposed to it could withstand its action for any length of time; and hence it was that bodies were so soon destroyed when exposed, as one gentleman had described it, to the "cutting action of the flame." The flame in the first stage being composed of innumerable lightning explosions accounted also for its radiant power. A flame radiated much better than a solid surface. A solid surface radiated only from its outer surface, and from that surface only toward one direction, while a flame radiated from every point within it, and on its surface in every direction or from every point within it and on its surface in every direction or from every point of its entire volume toward every direction. The Argand burner would serve as an illustration of a hollow flame, the light radiating outward, not only from the outer surface, but from the inner surface through the flame itself; the heat and light obeyed the same law in this respect. If the area of a flame was doubled it would radiate four times as much as originally; whilst a solid body, if doubled in area, would radiate only twice as much as before. That only accounted for the employment of such a large volume of flame in applying radiation; in fact, it could not be made too large from an economical point of view, because the radiation from a body of flame increased in a much greater proportion, than the increase in its volume. In the second stage of the flame where no chemical action was going on, there was also no free carbon to emit heat by its incandescence, and it was therefore natural that there should be little radiant action.

As stated by the distinguished author of the paper quoted from, his experiments have established the following most important fact, namely, "*that a good flame, or in other words perfect combustion, can only take place in an open space, or in one of sufficiently large size to allow the gases to burn out of contact with solid material.*" This being established, it is an important advance in our knowledge of the conditions which must exist to produce perfect combustion. It has long been known, that the temperature of flame is very high —4,000 deg. Fah. Mr. Siemens says—and that when it is reduced, combustion ceases. For this reason, fire-brick has been used a good deal in boiler furnaces in the form of brick-ashes and otherwise, because it does not conduct the heat away from the fire as rapidly as plates do which are in contact with water. Mr. Verderber, a Hungarian engineer, some years ago, experimented with a locomotive boiler, the fire-box of which was lined with fire-brick and which had no water spans at all around the fire; the object being to maintain a high temperature and thus produce more perfect combustion. The experiments of Mr. Siemens show that not only is a high temperature essential, but that "when flame is brought into contact with any solid body it is more or less quenched." The inference which may fairly be drawn from these considerations is that combustion should be carried on in a fire-box whose sides consist of some non-conducting material and that the fire should come in contact with these sides as little as possible, that is, that the flame should have "free space." This means that the fire-box should be large, and if it was made of a spherical or cubical form its sides would present the least surface to the fire. Here the practical men have again been ahead of the theorists, as the old-fashioned "egg-shaped stove," for burning bituminous coal, fulfills all of the above conditions.

Of course a fire-box without heating surface would not generate any steam, and all the heat from the fire would be transmitted to the water in the tubes. As they would then have more work to do, it would be essential that the amount of heating surface in them should be increased. This could be done by adding to their number or to their length, or by adopting ribbed boiler-tubes, such as were illustrated in the last number of the JOURNAL.

These considerations then suggest that a locomotive boiler with a large fire-box, approximating as nearly to a cubical form as practicable, lined with fire-brick, and with a small open grate and an increased flue area, would be more economical than the boilers now in use.

NEW PUBLICATIONS.

TECHNOLOGY QUARTERLY: VOL. I, NO. I. Issued from the Massachusetts Institute of Technology, Boston.

THIS new magazine is intended to represent, as far as possible, all the departments of the Massachusetts Institute of Technology, and is published by a board of editors chosen from the Senior and Junior classes of the Institute. Its object, as stated in the introductory number, is to preserve the results of original investigations made by students in the course of their work, and it is also expected that the articles of this class will be supplemented by contributions from the Alumni of the Institute. The student contributions, however, are to form the basis of the work.

It is probable that there will be little or no difficulty in securing material enough for a very creditable quarterly on this basis. This first number contains contributions from the departments of civil, mechanical and electrical engineering, chemistry and natural history, covering a very extended field.

BOOKS RECEIVED.

THE RELATIONS OF RAILROAD MANAGERS AND EMPLOYES; BY DR. W. T. BARNARD. Baltimore; Press of the Employés' Relief Association.

FIFTH ANNUAL REPORT OF THE BALTIMORE & OHIO EMPLOYES' RELIEF ASSOCIATION; S. R. BARR, SECRETARY. Baltimore; issued by the Association.

SPECIAL REPORT OF THE MASSACHUSETTS RAILROAD COMMISSIONERS TO THE LEGISLATURE ON THE DISASTER ON THE DEDHAM BRANCH OF THE BOSTON & PROVIDENCE RAILROAD. Boston; State Printers. This is the report of the Commission on the Bussey Bridge Accident of March 14, and is referred to elsewhere.

STATISTICS OF THE AMERICAN AND FOREIGN IRON TRADES FOR 1886; ANNUAL STATISTICAL REPORT OF THE AMERICAN IRON & STEEL ASSOCIATION; JAMES M. SWANK, MANAGER. Philadelphia; issued by the Association. This report, as usual, contains much valuable statistical information, some of which we have already made use of elsewhere.

THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC; 1887. Washington; issued by the Bureau of Navigation, Navy Department.

SELECTED PAPERS OF THE CIVIL ENGINEERS' CLUB OF THE UNIVERSITY OF ILLINOIS; 1885-86 AND 1886-87. Champaign, Ill.; issued by the Club. This contains papers read before the Club on Economical Specifications; Topographical Surveying; Street Pavements; Wind Pressure; City Engineers' Work; Breakwaters at Chicago; Water Supply for Cities; Mountain Railroad Location and Hints to Students on the Education of an Engineer. The last-named paper is by Professor Baker; the others are by student members of the Club and show evidences of creditable work.

TRANSACTIONS OF THE INSTITUTION OF CIVIL ENGINEERS OF IRELAND; FIFTY-FIRST SESSION. Dublin; printed for the Institution.

PROCEEDINGS OF THE UNITED STATES NAVAL INSTITUTE: VOLUME XIII, NUMBER I. Annapolis, Md.; published by the Institute.

UNITED STATES GEOLOGICAL SURVEY; MONOGRAPH X. DINOCERATA. By O. C. Marsh.

BRIDGE DISASTERS IN AMERICA. THE CAUSE AND THE REMEDY. By Professor George L. Vose. Boston; Lee & Shepard, Publishers.

PROCEEDINGS OF THE GENERAL TIME CONVENTION: Held at the Hotel Brunswick, New York, April 13 and 14, 1887. W. F. Allen, Secretary.

THE OFFICIAL RAILWAY LIST FOR 1887. Chicago; published by the Railway Purchasing Agent Company. This an exceedingly useful publication, containing a directory of the railroads of the United States and Canada, with the names and addresses of the officers, including those of the engineer and mechanical departments. It is of convenient size and well adapted for a place on the desk.

LIGHT ON THE LAW: A REFERENCE BOOK ON THE ACT TO REGULATE COMMERCE. The *Railway Age* Publishing Company, Chicago. This is a convenient handbook, containing the new Inter-State Commerce Law, with much collateral matter intended to throw light on its provisions. This collateral matter includes the Reagan and Cullom bills as originally presented to Congress; a summary of the debates in Congress which preceded the enactment of the law; opinions of Mr. Albert Fink and others on the law; the organization and first official actions of the Commission. It is illustrated by portraits of the five Commissioners.

NATURAL PRINCIPLES REGULATING RAILWAY RATES; BY GERRIT L. LANSING. Chicago: the *Railway Age* Publishing Company.

RECORD OF TRANSPORTATION LINES OWNED AND OPERATED BY AND ASSOCIATED IN INTEREST WITH THE PENNSYLVANIA RAILROAD; 1886. This statement or report, issued yearly by the company, shows that on December 31 last, the lines of the company were in all 7,404.37 miles in length, having 11,720.39 miles of track; an increase of 116.42 miles of road and 270.62 miles of track in 1886. Of these lines 4,415.44 miles were included in the Eastern system, east of Pittsburgh and Erie, and 3,249.93 miles were west of Pittsburgh.

THE EAMES VACUUM BRAKE COMPANY; FREIGHT BRAKE CATALOGUE. Issued by the Company; office in Boston, works at Watertown, N. Y.

DESCRIPTIVE CATALOGUE OF RAILROAD SWITCHES, FROGS, CROSSINGS, ETC.; PENNSYLVANIA STEEL COMPANY. Steelton, Pa.

BOLTS, NUTS, AND SCREWS: TRUMP BROTHERS MACHINE COMPANY. Wilmington, Del.

OBITUARY.

MR. PETER EMSLIE, who died in Buffalo, N, Y., May 8, aged 72 years, was a civil engineer who was for many years connected with the Lake Shore & Michigan Southern road. He designed some very fine masonry structures —culverts and bridges—for the road, and was very much interested in this branch of his work. Some years ago he had charge of the building of the State Insane Asylum at Buffalo. He retired from active work a few years ago.

PROFFESSOR WILLIAM ASHBURNER, who died in San Francisco, April 20, was a mining engineer of high standing and wide reputation. He was born in Stockbridge Mass., in 1831, and after the usual school course, passed two years in the Lawrence Scientific School of Harvard College and three years at the Ecole des Mines in Paris, where he graduated in 1854. On returning to this country he devoted some time to an examination of the Lake

Superior mineral region. In 1859, he was engaged in some explorations in the island of Newfoundland. In 1860, he went to California as assistant to Professor J. D. Whitney, Director of the State Geological Survey. From 1862 to 1883 he was engaged as a consulting mining engineer, his work taking him not only to various parts of the United States, but to British Columbia, Mexico, South America and even to Asia. In 1874 he was made Professor of Mining in the University of California, and subsequently Honorary Professor. He held various offices of trust in California, having served as Commissioner of the Yosemite Valley, Regent of the University, a trustee of the School of Mechanical Arts and a trustee of the new Stanford University. He was an active member of the California Academy of Sciences and of other technical societies on the Pacific Coast, and had many friends.

MR. FRANKLIN A. COMLY, for many years prominent in Philadelphia from his control of extensive coal and iron interests, died at his home, at Fort Washington, Pa., April 23. He was born in 1813 on the Pennypack at the place now as known as Bethayres, his parents being members of the Society of Friends. After passing through the schools in the vicinity he received a higher education in an academy in Philadelphia, and then went into the hardware business, first as a clerk and afterward as a partner of the old house of Parrish & Co In 1844, Mr. Comly became connected with the mining and shipping of coal, and was elected President of the Buck Mountain Coal Company, whose mines were situated in what is now Carbon County, Pa. In January, 1857, he was chosen President of the North Pennsylvania Railroad Company, as the successor of the late Hon. John Welsh, and has filled the office ever since. He was also President of the Longdale Iron Company, of Virginia, and of the Quinnimont Coal & Iron Company, of West Virginia; Treasurer of the Andover Iron Company, of Phillipsburg, N. J., of which he was one of the incorporators, and director of the Glendon Iron Company, of Easton, Pa.; the Allentown Rolling Mills; the East Broad Top Railroad Company; the Cranberry Iron & Coal Company, of North Carolina; the East Tennessee & Western North Carolina Railroad Company; the Hibernia Mine Railroad Company; the Pennsylvania Fire Insurance Company; the Long Branch Railroad Company; the Northeast Pennsylvania Railroad Company, and the Delaware & Bound Brook Railroad Company. He was also formerly a director of the Philadelphia & Reading and the New Jersey Central railroads. The deceased was unmarried; he leaves a considerable estate.

W. C. DEPAUW, one of the best known manufacturers in the West, died in Chicago, May 5, having been stricken with apoplexy while visiting that city on business. Mr. DePauw was a resident of New Albany, Ind., whose manufacturing industries were largely built up by him. He was born at Salem, Ind., in 1821. His father was not able to give his son much of a start in life, however, but left him to become the architect of his own fortune. In 1844, when he was a poor man, he was elected Clerk of the Courts of Washington County, and from his savings in office he laid the foundations of his wealth. He entered the banking business in 1854 and became President of the Bank of Salem. In 1861 he removed to New Albany, and became one of the heaviest contractors for army supplies in the West. He erected the large plate-glass factory at New Albany, and under most discouraging circumstances succeeded in establishing the business, which was new in this country, on a firm basis. Subsequently he became interested in the New Albany Rail Mill Company and the Ohio Falls Iron Works, as well as in woolen and cotton mills, foundries and other manufactories at that point, at Louisville and at Indianapolis, being a large stockholder in the Indianapolis Rolling Mill Company. He continued his connections with the banking business, and at his death was interested in a number of banks in Indiana and at Louisville and Chicago. Born and reared in Indiana, and residing there during the whole of his life, he was probably its wealthiest citizen when he died. He was also its most liberal citizen, having given large sums in charity and for religious and educational purposes. His donations to the Methodist Church amount to $1,000,000, and his will provides for a bequest of not less than $1,500,000 to De Pauw University, at Greencastle, Ind., to which institution he had already given over $300,000. His sons, who will have the management of his large estate, have been carefully trained to business.

Contributions.

Admirable Railroading.

To the Editor of the Railroad and Engineering Journal:

AN observer who can appreciate the difficulties which have to be surmounted in order to make two trains starting from different places reach a common center at almost exactly the same moment of time, and roll into a depot side by side, cannot but be impressed with the accuracy and precision which characterizes the operation of the trains on some of our great railroad systems. The writer was so impressed with the exactness of time of two trains, starting from widely divergent points, and yet reaching their destination at the same time with an accuracy bordering almost on perfection, that he cannot help but give it for the benefit of the readers of the JOURNAL. This occurred on Sunday, May 22, when the Little Miami train, which leaves Louisville, Ky., by the Louisville & Nashville, at 2:30 A. M., and the train leaving St. Louis, by the Vandalia Line, at 8 P. M. the night before, entered the arches of the Union Depot, in Columbus, O., with the points of their pilots not more than 15 in. apart. To see these two trains with engines of the same class, cars of the same kind and both arriving at the same time, is indeed a thing that must be admired by any one who can appreciate and realize what a grand thing railroading is at this time. These trains, with their sleeping and parlor cars, are consolidated into one train and run on to their destination, which is New York.

OBSERVER.

GEODETIC WORK IN THE UNITED STATES.

IV. THE U. S. COAST AND GEODETIC SURVEY.

BY PROF. J. HOWARD GORE.

AS the ideas of a people, as well as those of an individual, are strengthened and improved by contact and association, each nation has advanced and enlarged its interests by communication with other nations, or dwarfed them by confinement, so that one might take, as the exponent of a nation's prosperity, the amount of wealth that is going to and fro on its high seas. And though for many years after the arrival of the first settlers in America the attention of her people was feverishly directed toward the discovery and development of her resources, still the dependence upon the parent lands for those articles which the new enterprises failed to supply, the alluring call for recruits and their prompt responses, were such as to put into action a maritime intercourse that has grown with each passing year. And, while growing, the shores which bound our most frequented ports were again and again strewn with wrecks—each a sad commentary upon the ignorance regarding the shoals, reefs and dangerous shore-lines. In order to diminish the dangers to which a ship and her cargo are subjected, every Euro-

pean country having a foreign commerce at stake has instituted an accurate survey and delineation of its entire ocean boundary, not only as to its apparent outline, but also as to the character of the soundings leading into deep water. Although the successful prosecution of such works involve enormous outlays, still the assuring thought comes that the loss of all the vessels bound for a single port within one year would more than balance the entire expense.

The first appeal to our general government for assistance in carrying on a survey of the coast came from Messrs. Parker, Hopkins and Meers, who, in the latter part of the past century, made the necessary observations and examinations, and collected all the data requisite for a chart of the coast of Georgia, from St. Marys to Savannah, together with its harbors, rivers and inland navigation. In doing this, they exhausted their resources; they then petitioned Congress to appropriate $3,oco to enable them to engrave their charts. This petition was referred to a committee who, in a report submitted February 27, 1795, expressed an opinion favoring the work in general, but without a promise of the acceptance of this special proposition. The conclusion of this report was a series of resolutions, the first being: "That the President of the United States be requested to obtain, as soon as possible, complete charts made out from actual survey and observation of the sea coast, from St. Mary's River, in Georgia, to Chesapeake Bay, inclusive, and that——dollars be appropriated for that purpose." The other resolutions suggested that the work be done State by State, that results already collected might be purchased, that revenue cutters be employed as far as possible, etc. This report was referred to another committee, who made a report, on December 29 of the same year, which was almost identical with the first as to preamble and the first resolution quoted above, but nothing further was recommended as to the ways and means by which the survey was to be prosecuted. These memorialists, either because of their interest in the work or their desire to be reimbursed for the outlay they had already made, were not discouraged at the failures so far experienced, but secured further consideration of their petition, this time by the Committee on Commerce and Manufactures. This committee, on May 14, 1796, recommended: "That the President of the United States be requested to procure such accurate charts of the Atlantic coast of the United States, including the bays, sounds, harbors and inlets thereof, as have been made from actual observation and survey; and that, in all those parts of which no actual survey has been made, or where the same, in his opinion, be inaccurately done, he be requested to employ proper persons to survey and lay down the same, and to order the revenue cutters of the United States on that service, whenever, in his judgment, it can, without inconvenience to the public, be done." There was another resolution providing that, whenever the work of any person or persons was accepted, compensation should be tendered, together with the right and privilege that the maker publish the charts and hold the copyright to them. Although this method of carrying on the survey of the coast was never put into practice, nor Messrs. Parker, Hopkins and Meers ever recompensed for the work they did, this petition was unquestionably the first public expression of the needs for a coast survey.

The next step taken in this direction was the outcome of a suggestion of the Committee on Commerce and Manufactures, in its report made February 27, 1806, upon the expediency of making a survey of the shoals of Cape Hatteras, Cape Lookout and the Frying Pan. The significant clause was: "The Committee are fully apprised of the importance of having accurate surveys of the whole American coast, and they ardently hope that Congress will, at the next session, direct a complete examination to be made of it, from the St. Croix to the Mississippi, and to the extreme southwestern part of Louisiana in the Gulf of Mexico, including all our valuable harbors, bays and inlets, and we ought not any longer to rely on foreign charts for a knowledge of our own coast, when errors and omissions of great magnitude are known to exist in by far the greater part of them; and when, too, it is considered that corrections are seldom made in the American copies, it is presumed that there can be no doubt of the propriety of directing the earliest attention to this interesting subject."

This report also embodied provisions for completing a survey of the coast of North Carolina. Two Commissioners, Thomas Coles and Jonathan Price, were appointed for this undertaking—completing it during the following summer. In submitting their report to Congress, Mr. Gallatin, then Secretary of the Treasury, spoke of their chart as being more correct than any extant. The methods employed in this, the first hydrographic work, present a striking contrast to those of the present day. It appears that astronomic observations were made at only three stations; longitude was determined from lunar-distance observations, while the way in which they observed for latitude is not given. A large number of soundings were taken, though nothing is said regarding the plan adopted for locating the points at which they were made. Here and there, the directions to headlands are stated, but without any information as to the details of their operations.

This much space has been given to the antecedents of the Coast Survey in order that it may be clearly understood to what extent it was indebted to them. Up to this time, no attention was paid to the location of points trigonometrically, so the person who first suggested this plan is the one whom we must thank for the conception of a method which has, in its subsequent elaboration, reflected so much credit upon his followers. Just who this person is it is difficult to say, but the general impression is that it was Robert Patterson, at that time Director of the Mint at Philadelphia. Being acquainted with President Jefferson and the members of his Cabinet, he had free access to them; this, added to Jefferson's enthusiastic interest in all scientific matters, made it an easy task to secure at least a consideration of such projects as he might make. At all events, the act of Congress of February 10, 1807, was passed upon the recommendation of the executive. It appropriated $50,000 "For making complete charts of our coast, with the adjacent shoals and soundings." The best means of putting the act into effect was not at once apparent to the President, nor to his Secretary of the Treasury, Mr. Gallatin. So the latter, under date of March 25, 1807, issued a circular setting forth a project o: a survey and requesting outlines of such a plan as might unite correctness and practicability. According to the scheme sent, the operations were distributed under three distinct divisions:

1. "The ascertainment by a series of astronomic obser-

vations the true position of a few remarkable points on the coast; and some of the light-houses placed on the principal capes or at the entrance of the principal harbors, appear to be the most eligible places for that purpose, as being objects particularly interesting to navigators, visible at a great distance, and generally erected on the spots on which similar buildings will be continued so long as navigation exists.

2. "A trigonometric survey of the coast between those points of which the position shall have been astronomically ascertained: in the execution of which survey, the position of every distinguishable permanent object should be carefully designated, and temporary beacons be erected at proper distances on those parts of the coast on which such objects are rarely found.

3. "A nautical survey of the shoals and soundings off the coast, of which the trigonometrical survey of the coast itself and the ascertained positions of the light-houses and other distinguishable objects would be the bases, and which would, therefore, depend but little on any astronomical observations made on board the vessels employed on that part of the work.

The circular also requested the names of such persons as could be recommended as capable of acting in the different parts of the work. They were sent to Robert Patterson, Andrew Ellicott, Secretary of the Land Office of Pennsylvania, Mr. F. R. Hassler, then in Philadelphia, John Garnett, of New Jersey, Isaac Briggs, of Maryland, James Madison, President of William and Mary College, and Joshua Moore, of the Treasury Department. The replies of these gentlemen give the best possible insight attainable into the condition of applied mathematics of that time. As a rule they advocated the determination of longitudes by finding local time from equal altitude observations upon the sun, and comparing this time with a chronometer set to the time of some known meridian after allowing for rate. It was thought that this method would secure results correct within two seconds of time. Latitudes were to be determined from meridian-altitude observations on the pole star, the error to be feared falling within 10″ or 15.″ The instrument suggested was a sextant or a whole circle of Borda. It was thought that 30 points so located along the entire coast would be sufficient, with, perhaps, the position of a few intermediate stations determined by rockets, powder-flashes or balloons. The triangulation was a feature that taxed their ingenuity, because they appreciated the difficulties that would attend such a work through a low, wooded country such as prevailed along the coast. The accuracy the most hopeful thought attainable was within 30″ for each angle, which, he said, allowing for the errors in determining the position of the initial point, and supposing the base-line to be correct, would, in a distance of 1,000 miles, about the length of our coast, give an error of only 660 ft.

The matter of instruments was also an important item, and one about which the majority of those consulted knew but little. However, one ventured to give a list, together with the probable cost of each; the whole amounting to a little more than $4,000, including a base apparatus which was to cost $50.

The above is a digest of the plans outlined by the Americans who were consulted, while the response of Mr. Hassler gives a scheme in which theory had been strengthened by practice. Mr. Hassler came to this country in 1805, fresh from geodetic work, having been engaged in the triangulation of the Swiss canton of Berne, and later enjoyed the rare privilege of working with Bohnenberger in Austria. He brought with him a rich experience, a valuable collection of instruments and a library of scientific works which, Garnett said, was the best in this country. This, added to a desire to lend his assistance to every worthy undertaking in his line, placed him in a position to make suggestions that must, of necessity, be inestimable in the organization and execution of such an important work. He proposed that there be measured, upon the whole extent of the coast, with a "*cercle repététeur à deux lunettes*," 1 ft. diameter, or, with an English theodolite of at least the same diameter and capable of multiplying angles, a chain of triangles, the sides of which should be about 60,000 or 100,000 ft., and established upon bases measured with the known means of exactness.

All the astronomical observations and deductions which circumstances may require, or which may be necessary, ought to be made in the course of the work at convenient points, as well for determining the latitude and longitude of those points, as the azimuths of the sides of the triangles. At the same time, as many secondary points and even simple directions ought to be ascertained as can be effected without impeding the principal design. In this way fixing the situation of light-houses, towns, villages and other important points on the coast which would serve for the continuation of the surveys in detail. The results should be laid down according to the differences of the meridians and parallels upon large paper divided into sections for convenience, and accompanied with a table of longitudes, latitudes, distances and azimuths.

The manner of keeping the record, taking soundings and making the astronomical observations was discussed quite freely. He proposed to use for a signal a triangular pyramid of from 10 to 30 ft. in height, from which a strong pole should proceed bearing a ball of 1 ft. in diameter, composed of potters' clay and covered with a good yellow varnish, forming a point of reflection, or a globe of 1½ or 2 ft. in diameter, formed of barrel hoops, covered with white or black cloth, according as the projection, in relation to the observer, falls upon the surface of the earth, in the sky or in the water. For night signals large argand lamps with wicks of 6 in. or more in diameter should be fixed upon the stations.

The plats above referred to were to be given to those who were charged with the detail survey, who should take the given points as bases, from which to fill up their portions of the survey as fully as may be desired, either with a small theodolite, a "planchette," a kind of plane table, sextant or compass, according to the accuracy and amount of detail necessary.

For off-shore work, he considered the three-point method unsafe, and advised the employment of two observers, one on land at a known station and the other on the boat, each of whom, at the time of sounding, should read the angle between the other and a second visible point.

The various plans were referred to a commission consisting of Messrs. Patterson, Briggs and Hassler, who, after giving each due consideration, agreed that they should recommend to the President the scheme of Mr. Hassler.

THE MILLER PLATFORM AND COUPLER PATENTS.

In February last, a suit of the heirs of the late Ezra Miller, against the Pennsylvania Railroad for infringement of his patents, was tried in the United States Circuit Court, in New York City.

As this case is an interesting one, it is now proposed to give a short history of it.

At the outset a brief history of the litigation will be given, and then the mechanical features of the case will be explained.

The Pennsylvania Railroad Company had been using the link-and-pin coupler and was desirous of getting a good coupling system for the road. In 1876 or 1877, Mr. Eli H. Janney brought to the attention of the officials of the road his coupler. This device was at that time not combined with any buffing system, other than that furnished by the couplings themselves. A number of cars were fitted with Mr. Janney's couplings, and much experimenting was done. After a time, this coupler having been adopted, it was determined to adopt a buffing system, which involved the use of the buffers, patented to Cummings, Patent No. 192,570, dated July 3, 1877. Just what the arrangement was will be spoken of later on, and drawings will be introduced illustrating the device in full.

Apparently, when the officials of the Pennsylvania Railroad Company had decided that the Janney devices were satisfactory to them, they proceeded to see whether in using them they would be infringing anybody's patents.

The Eastern Railroad Association is specially organized to meet such cases, and to this organization the road applied. The inquiry of the road was considered by the Association at the December meeting of 1877; it was sent to a committee and came up for final action in May, 1878.

The report of the committee was rendered after communication with Mr. Ezra Miller, the inventor of the Miller system of buffers and couplers. In the original request presented by the Pennsylvania Railroad Company to the Association, the following patents were cited: Patents Nos. 39,436, 138,405, 156,024, for improvements in car couplings, and also Patents No. 39,436, dated August 4, 1863, granted to Hazen Webster, and No. 192,570, granted to Cummings.

The specifications of the various patents and the drawings were annexed to the letter of inquiry. The patents submitted were those of Janney, Cummings and Webster.

The Committee after referring the matter to Col. Miller got from him the following letter:

"*New York, April 12, 1878.*

"*S. M. Whipple, Esq.,*
General Agent Eastern Railroad Association.
"*Dear Sir:*

"I have looked over the Janney patent papers, including patents No. 138,405, dated April 9, 1873, No. 156,024, dated October 20, 1874 and Webster, No. 39,436, dated August 4, 1863, and Cummings No. 192,570, dated July 3, 1877, and I am of opinion that they do not either of them infringe or at all interfere with my patents of March 31, 1863, and No. 38,057 January 31, 1865, and No. 46,126, and No. 56,594 of July, 1866.

"Your friend,

"E. MILLER."

After this letter from Miller to the Eastern Railroad Association, the Pennsylvania Railroad Company felt that it had a right to go ahead and use the devices, which it had taken the trouble to ask about so carefully.

Some time elapsed, and the Company had a number of the Janney devices in use, when it appears that Miller changed his mind partly and wrote another letter to the Eastern Association taking back in part what he had said in his previous letter and suggesting that as the devices were used upon the cars of the Pennsylvania Railroad Company's lines that he should be paid something. This letter seemed to indicate that the devices as used were not the same in Miller's estimation as those which had been submitted to him in the letter which the Eastern Railroad Association had sent him when asking his opinion previously. Miller never changed his views as to his 1863 patent. However, this letter was addressed to the Eastern Railroad Association and not to the Pennsylvania Railroad Company. The Association never transmitted the letter or a copy to the Pennsylvania Railroad Company, as this was no part of the regular business. As a result the Pennsylvania Railroad Company never knew anything about the letter and went along using the Janney devices in ignorance of the fact that Miller had changed his mind partly and now thought that some of his patents were infringed.

The next thing the Pennsylvania Railroad Company knew, it was sued by Miller under his three patents for infringing certain claims of each patent.

Miller brought the suit in 1883, and as, by this time, each of his patents had expired, he was forced to bring the case on the law side of the Court, which necessarily brought it before a jury. Had the patents been in force when the suit was brought the case would of course have been brought on the equity side of the Court, and the testimony would have been taken before an examiner, and the case would have been tried before a judge without a jury.

The case was called on February 1, 1887, before Judge Alfred C. Cox and a jury, and the trial was then proceeded with and lasted nine days. During the time that the case was reaching a hearing, however, Miller died, and it was proceeded with by his heirs.

The suit was founded upon the three patents of Miller, which are dated as follows: March 31, 1863, No. 38,057; January 31, 1865, No. 46,126; July 24, 1866, No. 56,594.

The patents had many claims, but certain ones were selected and pressed in the trial. The claims that the plaintiffs started in with were the following: In the case of the first patent, Claim 4; in the case of the second patent, Claims 1 and 4; and in the case of the third patent, Claims 1 and 3. During the course of the trial some of the claims were dropped or no testimony taken regarding them, as follows: Claim 1 of the second patent and Claim 1 of the third patent.

In this part of the article it is not intended that the mechanical features of the case should be dwelt on at length, and it is scarcely to be supposed that the legal aspect of the case would be of much interest to the readers of a mechanical paper, consequently as brief a statement of the trial will be given as will serve to give a clear idea of what took place.

The complainants (Miller's heirs) opened their case and proved infringement of the claims before referred to, excepting Claim 1 of the 1865 patent.

The defendant (the Pennsylvania Railroad Company) then proceeded with the testimony, in the case of some of the claims denying the infringement, and in the case of others insisting that the inventions were not new, or were not patentable. Later on these several claims will be specifically dealt with and considered. During the taking of the testimony the Miller side gave evidence of an

established license fee having been paid for the use of the three Miller patents as a whole. No license fee was shown to have been paid for any one or two of the Miller patents, but always for the use of the three patents, including all the several claims of each patent. This license fee was nominally $100 per car. Ezra Miller's son testified on the trial that, in about the case of 500 licenses, the amount per car came up to about $53. As the period during which the Pennsylvania Railroad Company was alleged to infringe the Miller patents extended from 1878 to 1883 it became a question as to what the license fee per car was during this period. A book of licenses was produced, covering the time of the alleged infringement by the Company. From this book it was difficult to deduce anything, but it appeared to show a license fee per car of about $25. This amount could not be clearly ascertained, as in most cases a lump sum was taken and this might have included 1 or 50 cars. In no case was there a license for anything except the use of all the three patents conjointly, embracing all that was covered by them. As the case went on, the claims, as above noted, were withdrawn, but this withdrawal of claims still left a claim of each of the three patents infringed. At the end of the taking of testimony, counsel for the defendant made a motion to dismiss the suit.

The only part of this which it is important here to dwell upon is as follows: It was asked, among other things, by counsel for the Pennsylvania Railroad Company, that the suit, so far as it related to the fourth claim of the 1863 patent, be dismissed, because on the face of the patent the claim was limited to a specific form of coupling head which the defendant did not have. This was a question of law and not of fact for the jury.

The Court, in this matter, held with the defendant that the fourth claim of the 1863 patent was not on its face infringed. This view, taken by the Court, left the complainants with only two patents in controversy. The Court further intimated that in the charge to the jury it would be necessary to tell them that the fourth claim of the 1865 patent could not be so construed as to make it for an invention which in any way differed from the earlier structures which the defendant had proved existed. If this had been charged, and had the case gone to the jury, then the complainants would have had only a single patent practically in controversy.

At this stage of the case counsel for the defendant called attention to the fact that where a license fee had always been paid for the use of the inventions of a number of patents, in a suit upon these patents, if all were not infringed, unless evidence was given of the value of the patents separately, only a verdict of 6 cents could be recovered.

Now, the Miller side, practically, had only one patent left in controversy, one being taken out by the Court, and the second likely to be practically taken out by the judge's charge when it came. No testimony had been given by the complainants as to the value of the patents separately, and, with this state of facts, and with the law as it applied to the case, the Judge announced to counsel that he would be forced to charge that the complainants could only have 6 cents damages at best.

After a careful consideration of the state of the case by counsel on both sides, it was determined by counsel for the defendant, the Pennsylvania Railroad Company, to accept a verdict of 6 cents as against the company. This he did because it saved a tedious summing up of the case, relieved the jury of two days' work and practically made the company a victor, for, as the patents had expired, the fact that the decision was for the complainants was not followed by an injunction, but left the road free to use the couplings and buffers which were upon its cars.

Before quitting the subject, there is one further fact to be noted regarding the fourth claim of the 1863 patent. When the devices used by the Pennsylvania Railroad Company were submitted to Miller as before noted, he gave the answer above quoted. After a time he took back his opinion in part. This change of view on his part, though it may have affected the 1865 and the 1866 patents, did not affect or include the 1863 patent, and, therefore, the Court held that the fourth claim of this patent was not infringed on its face, and that also the complainants were estopped, by Miller's own act, from saying that it was infringed. Even if Miller could have risen from the grave and have been put upon the witness stand, he himself could not have denied the fact that he had said that this claim was not infringed and that from this opinion he had never varied and could not now alter it.

These facts as to the litigation itself, may not seem of much interest to readers who are chiefly interested in the mechanical features of the case. However, without a comprehension of the facts as above stated, no true understanding of the matter can be had even, in its mechanical relations.

Before proceeding further, therefore, it is best that a clear understanding of the Janney coupler and buffer should be had. It was at first thought that the coupler alone, which can act as a buffer, would be sufficient. But later on it was determined that some form of seperate buffer had better be adopted. The object was to obtain a buffer which would check, in as great a measure as possible, the oscillation of the cars about an imaginary line passing through the center of the car-beds. This motion was not efficiently checked by the Miller buffer located in the axis of the motion, for, with such a buffer, the heads of the buffers merely rotate on each other, and the consequent friction is small. After considering the matter, Mr. Ely, General Superintendent of Motive Power of the Pennsylvania Railroad, partly matured a plan involving the use of the two side-buffers now employed in the Janney system. He had not time to work the matter out, and therefore turned the crude idea over to Mr. Janney, who perfected the mechanism necessary to the carrying out of Mr. Ely's ideas.

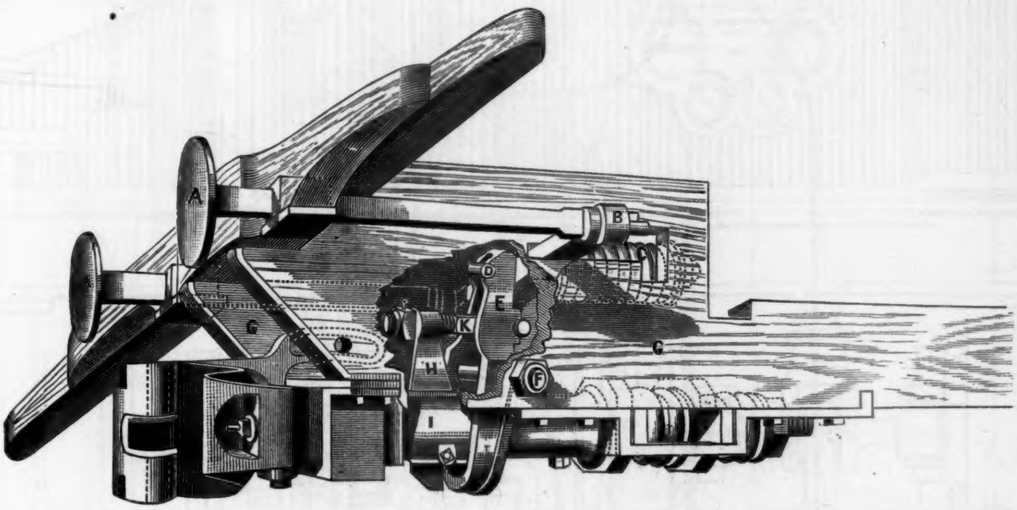
Among the requisites demanded by Mr. Ely was the following: That when the cars were coupled the engineman should not have to overcome the full force of the buffer spring to get the draw-faces of the coupling hooks together, while, at the same time, when in draft or compression, the buffers should, through the action of the couplers, exert an increased effect upon each opposite buffer.

Besides this it was also required that the buffers should be side and not central or axial buffers, so that when the cars oscillated the motion would be resisted by *metallic surfaces sliding past one another* under pressure, rather than, as in the Miller, by having surfaces which merely rotated upon each other. The first form of arrangement of parts presented a much greater resistance to oscillation than could be obtained by the Miller system or by any system

involving the use of buffers located at the center of the car or in the axial line of the car's oscillation.

These were the ideas, and they were embodied in practical shape by Janney in the following mechanical arrangement:

The first cut represents the Janney car coupler and buffer for passenger cars, and is shown as attached to the platform, a portion of the knees being cut away to show the workings of the apparatus.



The coupling being made between two cars, equipped as above, the faces of the side buffers *AA* are brought in contact with those upon the opposite car, and the thrust is communicated through the equalizing bar *B* to the buffer spring *C*, which is secured by means of a **T**-bolt, *D*, to the yoke *E*, which yoke is pivoted by means of a pivot bolt, *F*, passing through the platform knees *GG*.

The action of the yoke *E*, is peculiar, as, by its means, the buffers are thrust toward the pair upon the opposite car, whether *in the operation of coupling, or while the train is in draft.*

In the act of coupling, the natural tendency is to drive the coupling inward; when this inward movement takes place, the lower end of horn *H*, which passes vertically through the body of the coupler *I*, engages with the lower end of the yoke-lever *E*, and in throwing that end *backward* throws the upper end *forward*, hinging upon the pivot bolt *F*; the yoke carries forward with it, by means of the **T**-bolt *D*, the spring *C*, which, in turn, through the equalizing bar *B*, communicates the same forward motion to the buffers *AA*.

When the train is in *draft*, precisely the same action of buffers is obtained by the upper end of the horn *H* moving with the coupler and carrying yoke *E* forward by means of the **T**-bolt *K*.

The **T**-bolt *K* passes freely *backward* through the yoke *E* when the *couplers* are in compression, thus permitting the work of throwing forward the buffers to be done by the *thrust* of lower end of horn *H;* but when the coupler *I*, moves *forward* the **T**-bolt *K* comes into action and *draws* upper end of yoke *E* forward, with the result as described, and which may be followed out by anyone who will give the above cut a little study.

The essential features of the *coupling* will be understood by reference to figs. 1, 2, 3 and 4, which represent the Janney freight coupler. Fig. 1 is a top view of the

FIG. 1

FIG. 3

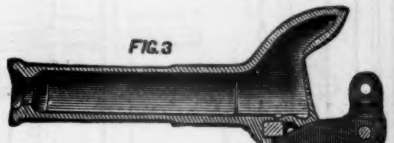
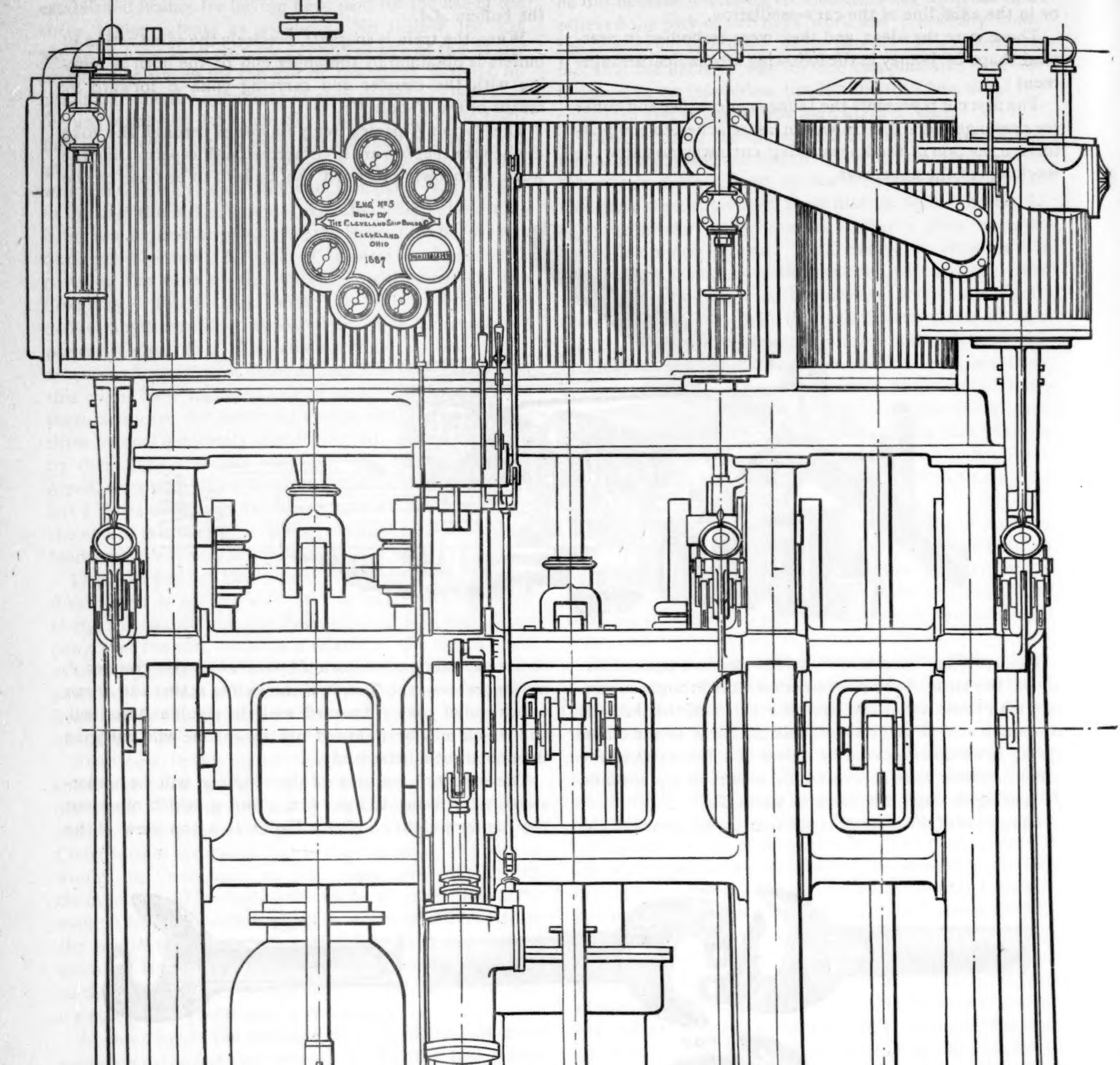


FIG. 2

FIG. 4

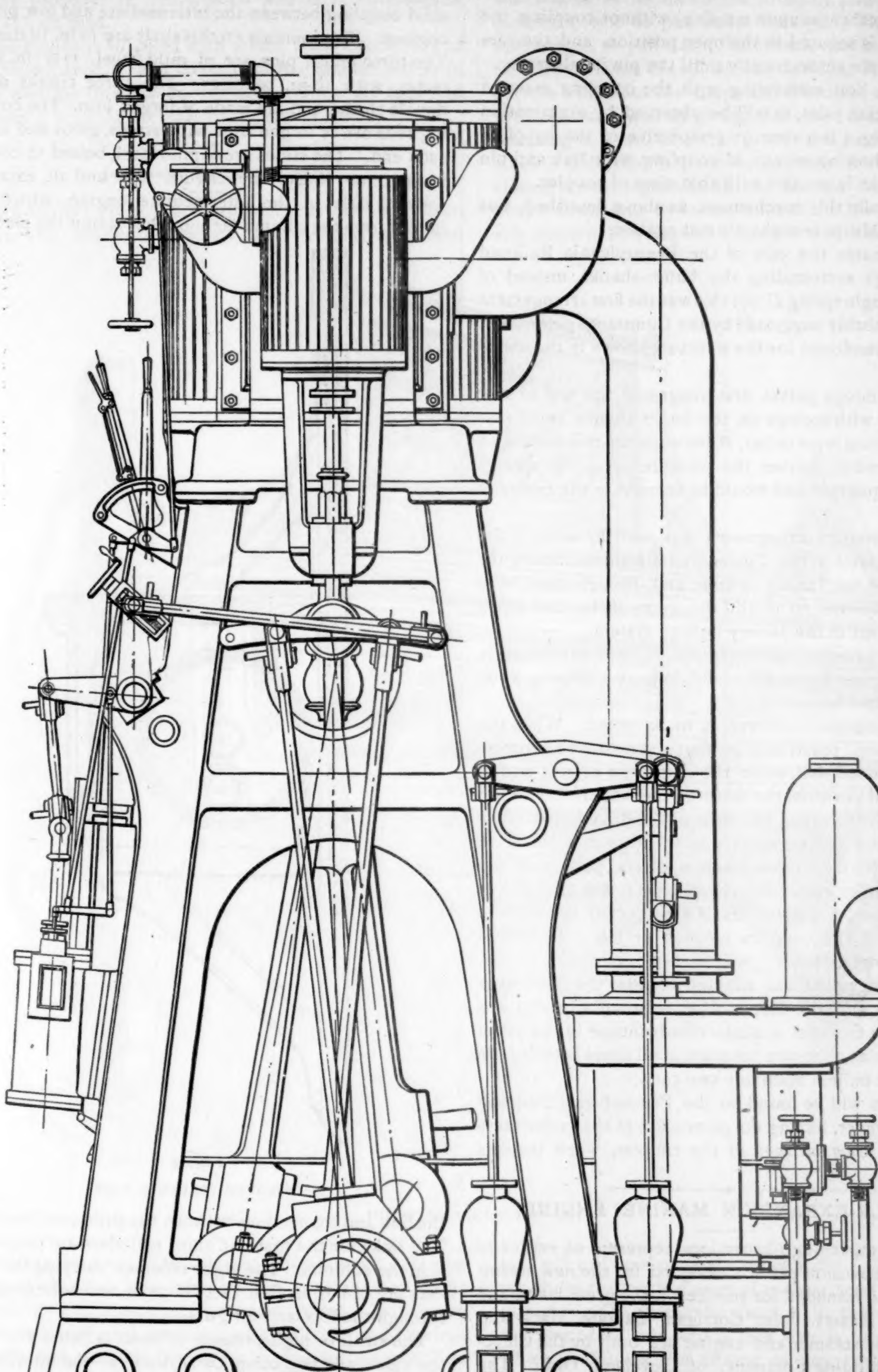
freight coupler, and represents the pair in proper position to effect the coupling, viz.: one hook closed and locked and one opened (both hooks may be open, but this is not necessary). Fig. 2 shows the coupling effected, and both hooks are locked as shown in fig. 3, which presents a section of the freight coupler when cut longitudinally, to show the method of locking the hooks by means of the gravity pin which drops in front of the point of hook, as shown in section. By a lift of this pin, which is effected by means of a lever at side of car, the point of the hook is freed when it is desired to uncouple, and when it is desired to



SCALE, 3/8 IN. = 1 FT.

TRIPLE EXPANSION ENGINES FOR STEAMER "AURORA."

BUILT BY THE CLEVELAND SHIP-BUILDING COMPANY, CLEVELAND, OHIO.



SCALE, ⅜ IN. = 1 FT.

TRIPLE EXPANSION ENGINES FOR STEAMER "AURORA."

BUILT BY THE CLEVELAND SHIP-BUILDING COMPANY, CLEVELAND, OHIO.

run cars together (as upon a siding) without coupling, the gravity pin is secured in the open position, and the cars will not couple automatically until the pin is released.

The draft bolt connecting with the coupling makes a ball-and-socket joint, as will be observed by examination of fig. 3. Fig. 4 is a view in perspective of the coupling hook, and showing means of coupling with link and pin when brought in contact with that class of coupler.

Substantially this mechanism, as above described, was that which Miller brought his suit against.

In some cases the cars of the Pennsylvania Railroad used springs surrounding the buffer-shanks instead of using the single spring *C*, but this was the first arrangement and was probably suggested by the Cummings patent, and was soon abandoned for the structure shown in the above cut.

The Cummings patent first suggested the use of two side buffers with springs on the buffer-shanks and a pivoted equalizing lever or bar, *B*, between the two buffers, so that in rounding curves the pressure upon the springs would be equalized and would be brought to the center of the car.

This Cummings arrangement was used by some of the connecting lines of the Pennsylvania Railroad before the adoption of the Janney system, and, though used in a different way, was no doubt the germ of the idea which was developed in the Janney buffing system.

A careful reading of the foregoing, will show clearly what the Pennsylvania Railroad Company was using when Miller brought his suit.

One other point, however, is to be noted. When the Janney system, practically as above shown, was adopted, Mr. Ely insisted that, when the cars were at rest and in their normal position, the faces of the buffers should not be set further out than the faces of the draw-hooks. The object of this arrangement was to prevent a shock in coupling. No doubt this location of the parts was had upon the earlier cars, but subsequently it was modified so that the faces of the buffers *AA* projected beyond the draw-faces of the couplers an inch or less. This made coupling more difficult.

This arrangement was adopted because the rapid wear of the parts and the lost motion required it, and it was deemed best to suffer a slight disadvantage in the act of coupling, so as to ensure pressure at all times between the faces of the buffers upon any two cars.

Many cars will be found on the Pennsylvania Railroad to-day, however, having no protrusion of the buffer faces beyond the draw surfaces of the coupler, when the cars are at rest.

TRIPLE-EXPANSION MARINE ENGINE.

THE accompanying illustrations represent an engine of the triple-expansion pattern designed for the new steamship *Aurora*, intended for service on the great lakes, and owned by Messrs. John Corrigan, Captain Mack and others. The steamer and engine are built by the Cleveland Ship Building Company, of Cleveland, Ohio. The engines are of the triple-expansion, direct-acting, jet-condensing type, and are expected to work up to 1,800 indicated horse-power. The three cylinders are 24, 38 and 61 in. diameter, respectively, having a common stroke of 42 in. The bed plate is of deep box pattern, cast in two parts, with the joint running athwartship, and carries the five journals of the crank shaft, which is in five pieces with solid coupling between the intermediate and low pressure engines. The journals on this shaft are 12 in. in diameter The three crank pins are of mild steel, 11½ in. in diameter, with 10-in. bearings. The three cranks are all double throw, and are made of forged iron. The connecting rods are of forged iron with straps, gibbs and keys in each end. The slides are of mild steel, bolted to columns in the center line of the engine, fore and aft, except the forward slide of the intermediate engine, which is removed from the column far enough to admit the placing of

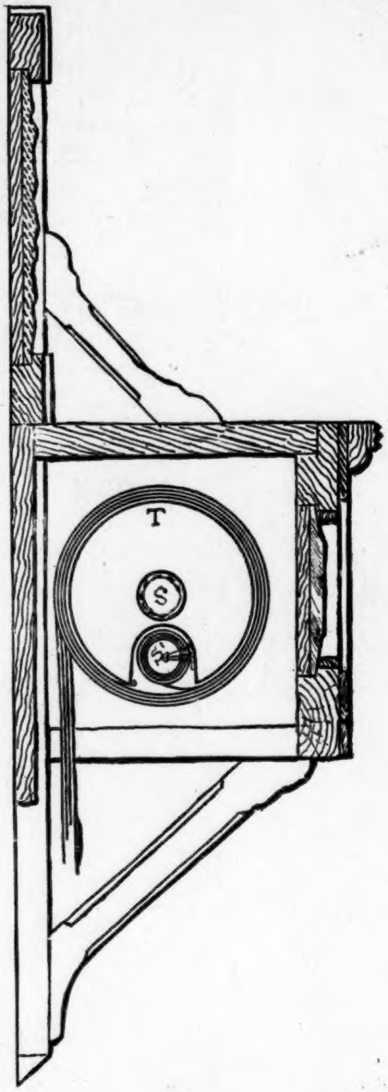


Fig. 2.
IMPROVED SCHEDULE CASE.

the link and connections between the slide and the column. The links for the first and third cylinders are placed outside the columns. The eight columns carrying the cylinders are of box section cast in pairs and bolted together through the fore-and-aft girts.

The small or high-pressure cylinder is fitted with a piston valve, and the other two cylinders—the intermediate and low-pressure—with slide valves, all being very easy of access for examination and repairs. The air pump is of the ordinary single-acting bucket arrangement, 28 in. in diameter and 17 in. stroke, and is so planned that any valve may be reached by taking off its cover. The condenser is of cast-iron, 35 in. in diameter and fitted with jet spray.

The propeller is four-bladed and is 13 ft. diameter and 17¼ ft. lead.

The engine is supplied with steam from two boilers of the Scotch type. Each boiler is 12 ft. diameter and 14 ft. long, and has three 40-in. furnaces. They are expected to carry a working pressure of 165 lbs. in service.

Improved Schedule Case.

THE subject of the accompanying sketch is a neat, cheap and serviceable device for keeping maps and schedules on file and within convenient reach. It consists principally of a wooden box without bottom, to which the wall-braces are securely attached. In this box there is placed, and provided with suitable end-bearings at each end, a hollow tin drum or cylinder marked *T*, to which the spiral spring *S* is fastened. The curtain or cover which is to act as a mantle to the maps and schedules when drawn down, is fastened directly to the spring-roller *S*. The schedules themselves are all clamped together and fastened to the back curtain, which, in turn, is attached to the roller before mentioned. The spring is so hung that when the schedules are all rolled up its tension will be at its minimum, while, by pulling down the curtain, it will be put under tension. The manner of operating is to pull down the outside curtain (which unrolls from the tin drum), then by holding fast the inside curtain which has the maps and schedules attached to it with one hand, and by giving the other a slight pull and releasing it, it will enter the groove and be out of the way when it is desired to refer to any map or schedule. In closing the arrangement up the outside curtain is again drawn down, and, by taking hold of the bottom of the inside curtain, by a slight lift, both it and the outside curtain will roll up around the tin cylinder. In hanging the schedules the vertical edge of each successive schedule is placed so as to overlap by about ¼ in. the similar edge of the preceding one, and in this way is formed an index which facilitates the finding of any particular map or schedule. This takes the place of large canopies, where sometimes from 12 to 20 or more rollers are used for maps, which is a bulky and inconvenient arrangement.

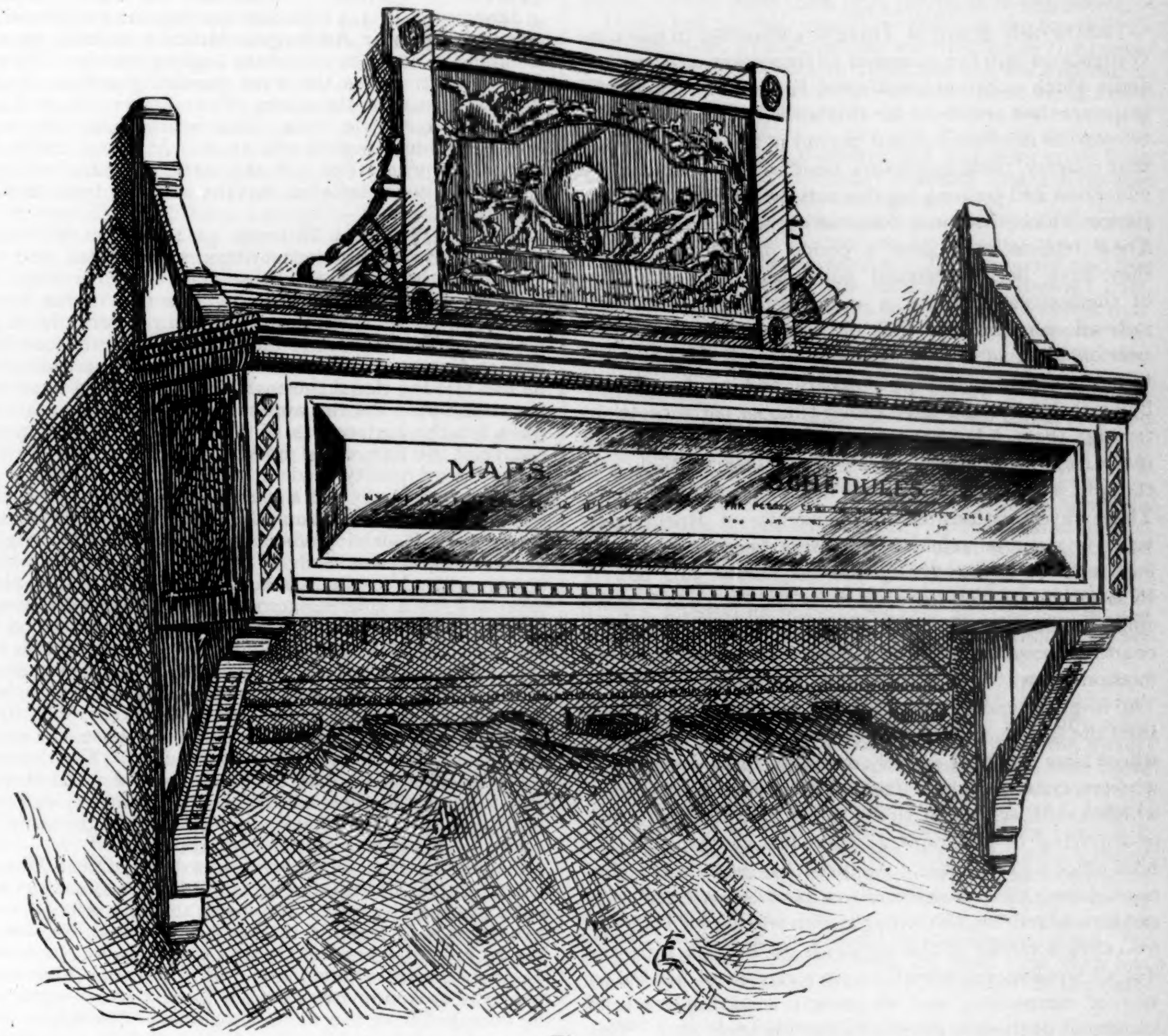


Fig. 1.

IMPROVED SCHEDULE CASE.

Mr. Berry, General Superintendent of the Pullman Company has one which holds 83 schedules. Most of the general offices of the Pittsburgh, Cincinnati & St. Louis system are provided with this improved schedule

case, and have the same in active and successful operation. An arrangement, with clock, air-gauges and indicator attached, for private cars has also been used; these gauges show the pressure in the main-brake pipe and cylinder, besides being a means for applying brakes and "bleeding" the cylinders when necessary to do so. The whole contrivance is beautifully and appropriately enhanced by the addition of wood carving and by putting in a bronze bas-relief.

BREAKAGE OF WHEELS AND TIRES ON BRITISH RAILWAYS.

THE British Board of Trade is authorized to make investigations into the causes of all important railway accidents which occur in the United Kingdom. Competent inspectors are employed for this work, and, as the system of rotation in office does not prevail in the civil service of that country, these inspectors, besides being qualified by education and training for this service, also acquire experience which fits them for making such investigations. Their reports now cover a period of about 35 years; they have been published and form quite a library of themselves, and are a mine of information about railroad management and of warning for the prevention of accidents. As these reports are inaccessible to most American railroad officers, and as they are so bulky that few could have either time or patience to go through them, it has been determined to make summaries of the reports of some classes of accidents which it is thought will be instructive and interesting to our readers. These investigations of the accidents on British railways, it must be remembered, have been made under authority of a law giving the inspectors full powers to ascertain all facts in each case, and hence are more complete than anything which can be looked for in this country, except in two or three States where railroad commissions exist with authority to investigate accidents. The English reports have also the advantage even then, from the fact that the inspectors, as noted above, are men whose time is almost entirely occupied in this work, and who are, consequently, trained experts, with an experience which a railroad commissioner rarely has the opportunity of acquiring in this country, where few are permitted to hold office a great while. As there has been much discussion over the comparative merits of American chilled car-wheels and English wrought-iron wheels with steel or iron tires, a record of the accidents on English railroads due to breakages of wheels or tires may be of service by way of comparison, and we present, accordingly, a brief statement of those accidents, beginning with 1853. This record has been carefully prepared from the inspectors' reports, and is intended to give the substance of those reports in a condensed form.

ACCIDENT REPORTS.

June 1, 1853, the engine of a passenger train on the Leeds Northern broke a tire on a leading wheel when near Wormald Green. The tire broke into three pieces and fell on the road-bed, a piece of it causing the brake-van, next the engine, to leave the rails and upset, killing the guard. The engine ran 1,050 ft. without leaving the rails. The leading wheel was 42 in. diameter, carrying about 3 tons weight. The tire was not much worn and had run 2,964 miles. The three pieces were 3 ft. 5 in., 1 ft. 10 in. and 5 ft. 2 in. long, respectively. The tire was of Lowmoor iron, shrunk on and fastened to the wheel by bolts. The Inspector finds that the weld was originally defective and one of the bolt-holes passed directly through it; one of the fractures, took place at this point, while the other was also at a bolt-hole. He recommends careful trying of the tires by tapping with a hammer.

August 22, 1853, a passenger train on the York & North Midland was derailed near Cottingham, and a third-class open carriage upset, killing two women. The derailed car was next the tender and ran about 1,200 ft. before the train was stopped. The derailment was caused by a broken iron tire on one of the wheels of the carriage. This tire broke at the weld, which seemed to have been an imperfect one, though fair on the original surface. It had been originally 1½ in. thick, but was worn down to ⅞ in.

January 12, 1854, a first-class carriage in an express train was derailed near Ambergate, Midland Railway, by the breaking of a tire on one of the leading wheels. The tire broke in two places, the weld remaining perfect; it was of good iron, from the works of the Patent Shaft Company, and but little worn. The weather was very cold, and the ground covered with snow. At about the point where the wheel first left the track a broken rail was found, but it was believed that this rail had been broken by the tire.

May 16, 1854, near Hornsey, on the Great Northern, rear brake-van of a passenger train was derailed, and the guard was thrown off and hurt. The tire of a wheel on the derailed van had broken and come off; it was found about ¾ mile back from the point where the train stopped. Traces were found showing that the tire had broken about two miles back; the injured guard said that he had tried to signal the engineman, but failed to attract his attention. The tire appeared to have broken at the weld, but the surface was so covered with dirt that the nature of the flaw could not be detected. The tire was iron, of good quality, made at the Lowmoor Works.

December 23, 1855, as a special express train was passing Swan Village station, Great Western Railway, the tire of the 6-ft. driving wheel of a standard-gauge engine broke, stripping the heads off eight of the rivets by which it was secured to the wheel, tearing up the station platform and fence, running across the highway and through another fence, and on its way killing a girl who stood in the road. Of this accident the Inspector says: "This accident appears to have been of an extraordinary nature, as the tire, with the exception of a single fracture, was found whole, but bent to the form of a cycloid. The fracture took place right across the tire and close to the weld, but not in the direction of the inserted V." The tire was made by Hood & Cooper, Leeds, and was of good fibrous iron, hard on the outer surface, and without any exterior indication of a small interior flaw existing at the point of fracture. It had run only about 2,000 miles.

January 21, 1855, a brake-van was derailed near Woodhead, on the Manchester, Sheffield & Lincolnshire line, and a guard badly hurt. It appears that a trailing wheel on a carriage in front of the van broke a tire; the wheel was broken to pieces and the axle torn from its place, and the broken wheel threw the van off. The tire (Lowmoor iron) was broken in two places, a piece 3 ft. in length being detached from the wheel altogether. The first break was at the weld, which showed a bad flaw in the center. The tire had been used six years, and was worn down to $1\frac{7}{16}$ in. thick on the tread.

February 19, 1855, a tire broke under a carriage of a passenger train on the Northeastern road, near Cramlington. The car was derailed, but ran nearly two miles before the engineman stopped the train. The guard saw the break at once, but had no way of signaling the engineman. The tire broke at the weld, where there was a large flaw in the center, the outside being perfect; it was of Lowmoor-iron, 2½ years in use. There was an opening of about 6 in. at the fracture, but the tire was not otherwise out of shape. The concussions following the break tore the leading axle from its place and the wheels and axles were thrown back against the trailing axle with such force as to tear it out from under the carriage, leaving it supported by the couplings alone.

February 20, 1855, as a passenger train on the South

Devon line was entering Brent station, a carriage left the rails but remained on the ties. The tire of a leading wheel broke at the weld, within an inch of one of the rivets holding it to the wheel-center. The broken end sprung out 5 or 6 in., but remained in contact with the wheel at the next rivet, 27 in. distant. The weld where the break took place was a jumped weld and very defective, though showing no flaw externally. The tire was Lowmoor iron, in use about two years.

February 22, 1855, at Four Ashes station, on London & Northwestern road, a goods wagon (freight car) was derailed by a broken tire. The tire was of iron, on a car belonging to the Newport, Abergavenny & Hereford Company, made for that road by Ashbury, Manchester. "The tire was fractured at the weld and was also split in a longitudinal and horizontal direction. It was composed of poor iron, badly forged and worse welded."

January 16, 1856, an express train on the Great Northern was derailed near Tallington, a first-class carriage being upset, injuring two passengers. A tire had broken at the weld; it was of Lowmoor iron, and had been twice turned off, the last turning leaving it 1⅛ in. thick.

December 3, 1856, tender of an express train was derailed near Thornhill Lees, Lancashire & Yorkshire Railway. Tire of a leading wheel broke and became loose from the center, jamming fast between the brake-block and the framing. From marks on the track it was thought that the tire broke at a bad rail-joint.

July 27, 1856, car of an express train on Newcastle & Carlisle line was derailed near Haltwhistle, 3 passengers being slightly hurt. The derailment was caused by the tire breaking at the weld; after the first break it seems to have broken into several pieces, which were scattered along the line. The tire was of iron from the Walker Iron Works; it was 1½ in. thick originally, but had been worn down to 1¼ in.

May 11, 1857, a four-wheeled fish truck in a mixed train on the Great Northern line was derailed near Barnet station. The coupling broke and the forward part of the train went on, but nearly all the cars behind the derailed truck left the track. A broken tire on a leading wheel caused the damage; it broke in five nearly equal pieces, through the rivet holes. One piece showed an old flaw, and the metal generally was much crystallized, having the appearance of poor iron.

May 1, 1858, a passenger train on the Manchester, Sheffield & Lincolnshire road was derailed near Oxspring by a broken tire on a trailing wheel of a passenger carriage. Three cars went off and were badly wrecked, after running some 1,200 ft. on the ties. It appears that a short piece of the tire broke out and was thrown off the wheel altogether; this was followed by a second and a third piece, and the third piece was thrown over on the opposite rail, striking the other wheel and causing the tire on that to break also. The tires were of iron, from the Blaenavon Works, and the Inspector reports that they were probably of poor iron originally, and had been rendered brittle by too sudden cooling. In addition, these brittle tires, nearly new, had been put under a jolting carriage and were on a section of the road not in very good order, especially as to the rail-joints.

August 5, 1858, the engine of a passenger train on the Great Northern line left the track near Carlton, ran entirely off the road-bed and upset. The cause was the breaking of a tire on one of the leading wheels, which was 42 in. diameter. The break took place at the weld, and a second break followed at a rivet hole, a piece 15 in. long being thrown off from the wheel altogether. The tire was of iron, nearly new, having run 10,120 miles. A bad flaw was found in the weld.

January 15, 1859, the engine of a passenger train on the Lancashire & Yorkshire broke a tire on a leading wheel near Crofton, and was derailed, the only damage done being the breaking of a number of chairs. The tire was of Lowmoor iron, and had run only 2,700 miles; it probably broke at the weld.

December 16, 1859, a wagon in a coal train on the London & Northwestern broke a tire near Wolverton, and a number of cars were thrown from the track and wrecked. One was thrown over on the opposite track, causing a subsequent collision. In this case the Inspector reports that the tire was of poor iron, the weather intensely cold and the breakage not remarkable. The wagon appears to have run nearly 3½ miles with the broken tire before it left the track.

December 18, 1859, a passenger train on the Midland road was derailed at Wichnor Junction by a broken tire under a passenger car, seven cars being thrown off. The tire was of iron, had run about 60,000 miles and had been turned up twice, reducing its thickness on the tread from 1¾ to 1¼ in. In this case the wheel-center was completely destroyed, the rim being broken in several pieces and all the spokes broken off. A piece of the broken tire was picked up two miles back from the point of derailment.

December 22, 1859, near Perry Bar, on the South Staffordshire road, a passenger car was derailed by the breaking of a tire on the leading wheel, and was much damaged. The tire broke in two pieces, the short piece being found 1½ miles back from point of accident, and the long piece near by. Maker of tire and length of service not known; it was 42 in. diameter and had worn down from 1¾ to 1⅛ in. thick on tread. It seems that a rivet hole had been drilled directly through the weld.

February 20, 1860, passenger train on Eastern Counties road was derailed at Tottenham by breaking of a tire of a leading wheel under the engine. Two trainmen and five passengers were killed, and sixteen other persons hurt. The iron tire had worn down to 1¼ in. but was less than 1⅛ in. thick over the weld. The Inspector reports that the break was due to a defective weld, the flaw not being apparent from the outside; he also holds that due precautions had not been taken to secure a sound weld. Concerning the usual practice with tires, he says: "The tires used on railway wheels are *shrunk on* to those wheels, or, in other words, are placed on them in a heated state, in order that they may grasp them tightly during the contraction of the metal in cooling. They are retained in their position on the wheel mainly by the state of tension into which they are thus brought. But they are also secured, in most cases, to the rim of the wheel by bolts. On some railways, the tire is so formed as to be dovetailed, as it were, when in its place, to the rim; and this plan is used both with and without bolts. The latter, when they are employed, give additional security.

"When the tensile condition of a tire, that is in good working order, is suddenly released by its being fractured, in consequence of a defect at the weld or from any other cause, then the tire has a tendency to fly off the wheel; and it requires stronger bolts, or better means than those usually employed, to prevent such a result from occurring."

The Inspector further recommends a method of fastening tires, then adopted by Mr. Beattie, of the London & Southwestern, in which the tire is rolled with an inside flange which buts against the rim of the wheel-center on one side; the securing at the other side being done by bolts tapped through the rim into the tire, or by wedges inserted in slots in the tire and then hammered down. He also speaks with commendation of steel tires, then just introduced for the first time by Mr. Sinclair, of the Eastern Counties line.

June 5, 1860, a passenger train on the Great Northern road was derailed near Southgate by the breaking of a tire on a leading wheel of a carriage. The tire was nearly new, 2 in. thick, and of good iron, secured to the wheel-center by bolts; it broke at the weld, which was very bad. The Inspector in this case again refers to the Beattie method of fastening tires.

December 26, 1860, at Blyton, on the Manchester, Sheffield & Lincolnshire line, a passenger train was derailed and seven persons hurt by a broken tire. The tire was on the trailing wheel of the rear carriage. The wheel was 36 in. diameter, the wrought-iron rim being ⅝ in. thick. The tire was 5 in. face and 1⅜ in. thick on the tread, was fastened to the inner rim by four ¾-in. rivets; it broke at three of the rivet holes. The wheel was of unknown age, and had been turned up eight months before.

December 26, 1860, part of a passenger train on the North Staffordshire road was derailed near Weston by the breaking of a tire. This tire was of iron, $1\frac{3}{16}$ in. thick on tread. It opened at the weld and broke the five rivets by

which it was attached to the center, then left the wheel altogether. The Inspector believed that, with proper attachments to the wheel, the opening at the weld would not have caused any accident. He also notes that the absence of rivet holes would add considerably to strength of tire.

January 4, 1861, passenger train on London, Chatham & Dover was derailed near Sittingbourne by a broken tire under a brake-van. Three cars were derailed and broken. The tire was from the Phœnix Works, 1¼ in. thick on tread and fastened to the wheel-center by four ⅝-in. rivets. It broke at a rivet hole and appears to have been shrunk on too tightly, causing undue tension. The Inspector again takes occasion to commend the Beattie method of fastening (already mentioned); the Gibson annular key fastening; the Mansell wheel with wood center, and the Brotherhood ring fastenings and one or two others. He suggests the use of a tire rolled with a flange, which would but against one side of the rim, and a projecting flange on the inside, which could be hammered down after the tire was shrunk on. In closing he says: "Although there is greater fear in general with regard to a slack tire, a loose tire or a broken tire, the most dangerous tire of all is one which has been shrunk too tightly on the wheel, and whose state of tension renders it ready to fly apart upon any violent blow adminisistered to it by a bad joint or an uneven crossing, in the ordinary course of traffic. This is the sort of tire that yields the clearest ring to the hammer of the examiner, and that inspires him frequently with the greatest degree of confidence; but this is the tire that ought in reality most to be dreaded."

January 4, 1861, passenger train on Shrewsbury & Hereford was derailed near Moreton by broken tire. It was an iron tire, eight months in use, had been turned up once and was 1½ in. thick on tread, fastened to the center by four ¾-in. rivets. It broke at the rivet-holes into four pieces.

January 14, 1861, express train on Great Western road was derailed near Twyford by a broken tire under a car. The wheel was 48 in. diameter, the iron tire 1⅜ in. thick; it had run 22,547 miles. The break was at the weld, where there was an internal flaw. A modification of the Beattie plan was used in fastening the tire on, but there were not clips enough to secure it properly.

January 3, 1861, passenger train on London & Northwestern was derailed near Berkhampstead by broken tire under a carriage belonging to the Caledonian Company. The wheel was 42 in. diameter, the tire nearly new, 1⅞ in. thick and fastened to the center by five ¾-in. rivets. It broke into three pieces, all the breaks being through rivet holes. It had run only 8,900 miles. A bad flaw was found in the body of the tire. The Inspector believes that this flaw might have been detected by careful inspection.

January 10, 1861, mail train on London & Northwestern was derailed near Bangor by broken tire. The tire was on a composite wheel, with cast-iron center, wrought-iron spokes and wooden felloes; these felloes came off when the tire broke. The tire was four years old and 1⅜ in. thick; it broke in six pieces and left the wheel altogether.

January 14, 1861, passenger train on London & Northwestern was derailed near Pinner by broken tire and four passengers hurt. The wheel in this case, as in the last, was a Worsdell wheel, with cast-iron hub, round wrought-iron spokes, wooden rims or felloes and wrought-iron tire. The tire (1⅜ in. thick) broke first, and the whole wheel seems to have came to pieces. The Inspector in both cases condemns this class of wheel as not sufficiently strong.

January 14, 1861, passenger train on Manchester, Sheffield & Lincolnshire was derailed near Lincoln by broken tire under the engine. All the cars were derailed, one passenger killed and two others hurt. The broken tire was on a leading wheel 4 ft. in diameter; it was about 1⅛ in. thick, having run 8,000 miles since the last turning. It broke in five pieces, which were scattered along the line. The Inspector believes that the break was caused by the thinness of the tire and the loss of strength from bolt-holes, and again recommends improved methods of fastening.

February 27, 1861, express train on London & Northwestern was derailed near Tring by the breaking of a tire under a carriage. The tire was a new one, 2 in. thick; it broke at the weld, showing a very large flaw, and opened out 21½ in. The tire was held on by an annular key or ring fitting in a groove turned in the inside of tire. This ring broke also and about 5 ft. of it were missing. The Inspector thinks the annular key was too light and very badly shaped and proportioned.

November 15, 1863, locomotive of a train on the Caledonian Railway was derailed, while going down the Bealtock incline, by the loss of a tire on a leading wheel. The engine upset and several coaches were thrown on top of it, killing a passenger and injuring five others. The tire broke in three pieces, 7 ft. 2 in., 2 ft. and 1 ft. 8 in. long, respectively. The leading wheel was 42 in. diameter and carried about four tons; the tire had run only 2,700 miles and was 2½ in. thick on tread. It was fastened to the wheel-center by five ⅞-in. bolts, and all the breaks were through bolt-holes. A remarkable feature of this accident is that the engine ran no less than 24 miles without the tire. The engineman noticed the rough motion and examined the engine at a station; he found a spring broken and, taking that to be the cause of the rough riding, looked no further.

February 12, 1864, a four-wheeled passenger carriage on the Caledonian road broke a tire when near the Bishopton tunnel. The car ran 2¾ miles before the train was stopped. The tire broke in two pieces, both of them being forced through the floor of the carriage, and one of them killing a passenger. The tire was old and had been worn and turned down from 1½ in. to ⅞ in. It was fastened to the center by four ¾-in. bolts and broke, first at the weld and then at a bolt-hole.

April 14, 1864, locomotive of express train on Great Northern line broke tire of a leading wheel when near Little Bytham and went into the ditch, nearly the whole train following it. The tire broke at the weld and was found in three pieces on the bank. It was of iron 5½ in. wide and 1¾ in. thick on tread, and had run about 30,000 miles. The wheel was 4 ft. diameter and carried about 5½ tons. The tire was fastened to the center by flat keys, on Beattie's plan. The weld was very defective. The Inspector here again urges the necessity of better methods of fastening.

In all the cases above given, the accidents were due to breakage of tires only. In each of the three cases where the wheel broke the breakage followed and was the result of the failure of the tire. The period covered by the accidents given (1853—1864) was that in which iron tires were in universal use, in fact, in one of the later cases, the Inspector mentions the use of steel as something new and commends its introduction.

In a majority of the cases, the failure seems to have resulted from defective welding; in many others from the drilling of bolt-holes through the tire. It is to be remarked, however, that there is no accident due to a loose tire to be found in the reports covered by the present statement.

(*To be continued.*)

Car-Couplers and Freight-Train Brakes.

[From the Ninth Annual Report of the Railroad Commissioners of Iowa.]

Of the importance and absolute necessity of automatic or safety couplers for freight cars, we feel that we cannot recede from the position taken in former reports. We are not, however, sure that the action taken by some of these States in making it the duty of the railroad commissioners of these States to select certain devices for coupling cars, is the shortest and best road to the desired end.

In quite an extended trip through some of these States, where the commissioners have selected several kinds of draw-bars which the railway companies may put upon their cars, a member of this board made it a special work to go into the yards at various places and ask of the yard

masters and men under them how they liked the new draw-bars. The answer invariably was: "We don't like them."

Then they would immediately qualify that answer this way: "If the companies would all agree upon one style of draw-bar and put that on, it would do; but, where there are a dozen kinds, we get confused sometimes when we are in a hurry, and we d—n all these new-fangled affairs, and wish there was nothing but the old link-and-pin."

There is a good deal to this. Michigan has selected some five which are lawful for the railways to put on. New York has chosen six. Massachusetts, five. Now, if other States should select different ones, it must be apparent to the most casual observer that the trouble and danger, instead of being lessened, might be increased.

The conviction is forced home upon us that the only competent parties to choose the coupler for general and universal use are the railroad companies themselves; the only needed legislation upon that point being such as will compel a choice within a reasonable time. It may not be out of place to mention here what seems to us some of the prominent hindrances in the minds of railway managers to a speedy decision of this coupler question. We think these are well-grounded reasons in the minds of all practical railroad men for the almost universal preference for a vertical, plain-hook coupler, after the fashion, somewhat, of the Miller coupler, now so common on passenger cars; but there has been a fear that such couplers would not afford the required slack in order to enable the engine to start the train and help it over sharp grades.

The experiments made last July at Burlington, in the freight-car brake tests, opened the eyes of a great many railroad men. To a great extent, the need of so much slack was shown to be a myth, and it is difficult to tell what those tests, there made, decided most—the true character of the coming safety draw-bar, or the best practical freight-car brake.

This difficulty of slack eliminated, then another very serious one confronts the railway manager.

There are some half-a-dozen or more hook couplers that are so nearly perfect and have so many points in common, no thinking man with the intelligence of the average railroad manager, but fears, if he decides upon any one, he is liable in buying and using it to buy a long, tedious and costly patent-right suit, for no one of the owners of these half-a-dozen hook couplers that are so nearly alike will see his competitor putting his coupler into general use and his own left, but who would, in all probability, at once commence suit for infringement. Could the proprietors of these several hook couplers pool their issues and combine their interest and unite good points of all in one, there is but little doubt that the railroad companies would at once adopt the consolidated draw-bar.

We are not uttering these thoughts at random. These conclusions are the result of quite extensive interviews with a large number of prominent railroad men, as well as with coupler men.

"Whenever these coupler men agree among themselves, where their couplers are so nearly alike and combine, we are ready to adopt some one of these hook couplers as a standard one, but we are not going to buy a lawsuit of any one of these inventors if we know ourselves," is the expression often heard from the lips of railroad managers. Thus we are inclined to the opinion that the safety-coupler men themselves are to-day standing in the way of a speedy adoption of the very thing they, the railroad companies and the public want.

Our attention has been called to the following law, passed by the Legislature of the State of New York (Section 4, Chapter 39, of the laws 1884), which, we think, more nearly meets the wants of the situation than anything in the way of legislation that we have seen:

"After July 1, 1886, no couplers shall be placed upon any new freight car to be built or purchased for use, in whole or in part, upon any steam railroad in this State, unless the same can be coupled and uncoupled automatically without the necessity of having a person guide the link, lift the pin by hand, or go between the cars. The corporation, person or persons operating said railroad, and violating the provisions of this section, shall be liable to a penalty of not exceeding $100 for each offense."

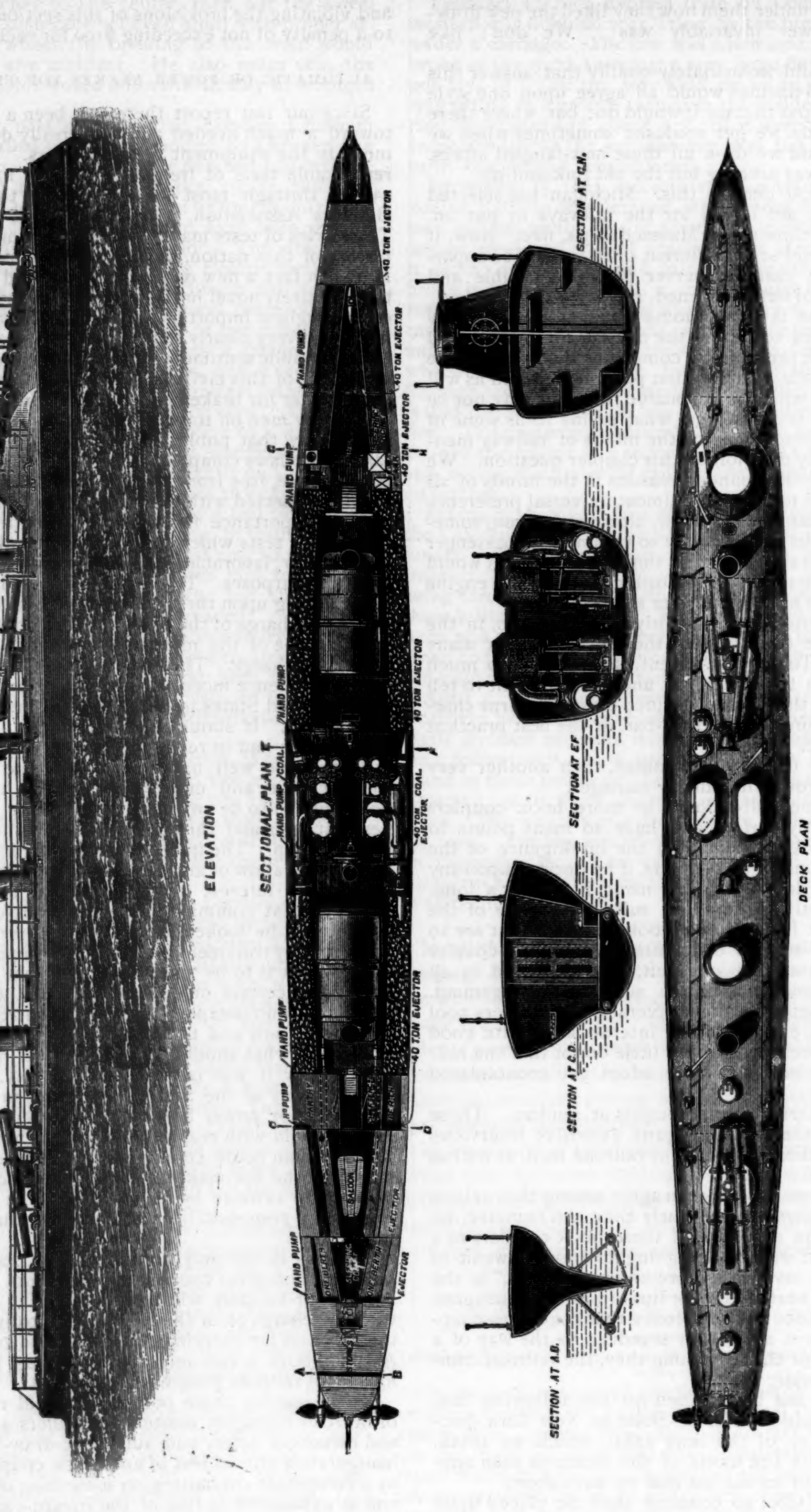
AUTOMATIC OR POWER BRAKES FOR FREIGHT CARS.

Since our last report there has been a long step taken toward a much needed and universally desired improvement in the equipment of freight cars. We refer to the remarkable tests of freight-car brakes inaugurated and carried through most successfully by the Master Car-Builders' Association, at Burlington, this State, last July. That series of tests marks a period of time in the railway history of this nation, second in importance to no other. It was, in fact, a new departure in railroad practice, something entirely novel in this country, but, at the same time, of the highest importance. As an indicator of the times it showed very clearly that railroad companies are keenly alive to public sentiment. They have seen that the public sentiment of this civilization was about to demand something better for brakemen than the common hand-brake, worked by men on top of freight cars.

They saw that public sentiment would eventually crystallize into laws compelling the use of some automatic or power brake, free from the dangers and exposure inseperably connected with those now in use, and it was of the utmost importance for them to know from actual and exhaustive tests which one of the several brakes pushed forward for favorable recognition was the best for all practical purposes. To us it does seem that the responsibility resting upon the Committee of Master Car-Builders who have charge of the tests, and who are to report on the same, is one of the most weighty that falls to the lot of man to discharge. The report of the Committee must, of course, influence more or less every railroad management in the United States in deciding what brake shall be used on its cars. It should also influence future legislation as it may be had in reference to safety appliances to cars. It should be well understood that the large expenditure of time and money to carry on these tests was not designed to be any mere child's play. It meant business through and through, no matter who went down or who went up. The interests at stake reached too far and too wide to allow of any swaying of judgment by any mere individual's interest in any particular brake. The final report of that committee, after the concluding tests next spring, will be looked forward to by every railroad company, and by trainmen as well as by shippers, with intense interest. It is to be sincerely hoped that that report will give no uncertain or double sound. It was chosen, and all this enormous expense has been incurred, to let railway managers know and to inform legislators what is *the* best brake, and what should be adopted. If not for this end, then surely it was indeed "child's play." Any action taken by any of the State Legislatures in reference to an automatic or power brake after the report of that committee, could with reason be based on that report, and no railroad man could complain. Any unnecessary delay of action by the law-making power after such report would be open to censure by trainmen and the public; hence, the heavy responsibility attaching to that forthcoming report.

Yet, this is the only correct way to reach the desired results. Too great commendation cannot be given to the master car-builders who inaugurated, to the committee who had charge of, or the railroad company that furnished the facilities for carrying through these important tests. As said above, a very important mile post is set up in the history of railroad progress in this land.

Before leaving these points, we would respectfully ask of railroad managers, master car-builders, and of inventors and owners of safety and automatic draw-bars: Why not inaugurate a crucial test of automatic couplers, conducted by a competent committee, on something of the same plan and as exhaustive as that of the freight-car brakes? Let this be done and all agree to abide by the report of the committee. We see no other way to reach the desired end unless it be the one suggested on another page in this report, viz.: By several of the vertical hook couplers combining and pooling their interests. Something should be done soon. The people will not allow Legislatures to



TWIN-SCREW TORPEDO BOAT FOR THE ITALIAN GOVERNMENT.

BUILT BY YARROW & CO., POPLAR, ENGLAND.

stand idly by and see the citizens of the State mangled and killed so unnecessarily as they now are by the use of coupling devices that have not been improved in the history of railroad work in this nation.

A Fast Torpedo Boat.

[From the London *Engineer*.]

In a recent impression we gave some particulars of the trial trip of a boat built for the Italian Government by Messrs. Yarrow & Co., which attained the highest speed known, namely, as nearly as possible, 28 miles an hour. On April 14, the sister boat made her trial trip in the Lower Hope, beating all previous performances, and attaining a mean speed of 25.101 knots, or over 28 miles an hour. The quickest run made with the tide was at the rate of 27.272 knots, or 31.44 miles per hour, past the shore. This is a wonderful performance.

In the following table we give the precise results:

	Boiler.	Re-ceiver.	Vacuum.	Revs. per min.	Speed.	Means.	2nd means.
	lbs.	lbs.	in.		Knots per hour.	Knots per hour.	Knots per hour.
1	130	32	28	373	22.641		
2	130	32	28	372.7	27.272	24.956	
3	130	32	28	372	22.784	25.028	24.992
4	130	32	28	377	27.272	25.028	25.028
5	130	32	28	375	23.225	25.248	25.138
6	130	32	28	377	27.272	25.248	25.248
Means	130	32	28	374½			25.101

The boat is 140 ft. long, and fitted with twin screws driven by compound engines, one pair to each propeller. These engines are of the usual type constructed by Messrs. Yarrow. Each has two cylinders, with cranks at 90 deg. The framing, and, indeed, every portion not of phosphor-bronze or gun-metal is of steel, extraordinary precautions being taken to secure lightness; thus, the connecting-rods have holes drilled through them from end to end. The low-pressure cylinders are fitted with slide-valves. The high-pressure valves are of the piston type, all being worked by the ordinary link motion and eccentrics. The engine-room is not far from the mid length of the boat, and one boiler is placed ahead and the other astern of it. Each boiler is so arranged that it will supply either engine or both at pleasure. The boat has therefore two funnels, one forward and the other aft, and air is supplied to the furnaces by two fans, one fixed on the forward and the other on the aft bulkhead of the engine-room. The fan engines have cylinders 5½ in. diameter and 3½ in. stroke, and make about 1,100 revolutions per minute when at full speed, causing a plenum in the stokeholes of about 6in. water pressure. Double steam steering-gear is fitted for the forward and aft rudder respectively, and safety from foundering is provided to an unusual degree by the subdivision of the hull into numerous compartments, each of which is fitted with a huge ejector, capable of throwing overboard a great body of water. A body of water equal to the whole displacement of the boat can be discharged in less than seven minutes. There is also a centrifugal pump provided, which can draw from any compartment. The circulating pump is not available because it has virtually no existence, a very small pump on the same shaft as the centrifugal being used merely to drain the condensers. These last are of copper, cylindrical, and fitted with pipes through which a tremendous current of water is set up by the passage of the boat through the sea. Thus the space and weight due to a circulating pump is saved and complication avoided. The air and feed-pumps are combined in one casting, let into the engine-room floor quite out of the way, and worked by a crank-pin in a small disc on the forward end of the propeller shaft. This is an admirable arrangement, and works to perfection

The armament of the boat consists of two torpedo tubes in her bows, and a second pair set at a small angle to each—Yarrow's patent—carried aft on a turntable for broadside firing. There are also two quick-firing 3-lb. guns on her deck. The conning tower forward is rifle proof, and beneath it and further forward is fixed the steering engine and a compressing engine, by which air is compressed for starting the torpedoes overboard and for charging their reservoirs. A small dynamo and engine are also provided for working a search-light if necessary. The accommodation provided for the officers and crew is far in advance of anything hitherto found on board a torpedo-boat.

The weather on the morning of Thursday, April 14, was anything rather than that which would be selected for a trial or indeed any trip on the Thames. At 11 A. M., the hour at which the boat was to leave Messrs. Yarrow's yard, Isle of Dogs, the wind was blowing in heavy squalls from the northeast, accompanied by showers of snow and hail. The Italian Government was represented by Count Gandiani and several officers and engineers. In all there were about 33 persons on board. The displacement of the vessel was as nearly as might be 97 tons. A start was made down the river at 11.15 A. M., the engines making about 180 revolutions per minute, and the boat running at some 11½ or 12 knots. During this time the stokehole hatches were open, but the fans were kept running at slow speed to maintain a moderate draught. The fuel used throughout the trip was briquettes, made of the best Welsh anthracite, worked up with a little tar. The briquettes were broken up to convenient sizes before being put in the bunkers. This fuel is not of so high evaporative efficiency as Nixon's navigation coal; but it is more suitable for torpedo-boat work, because it gives out very little dust, while the coal in closed stokeholes half smothers the firemen. Watering only partially mitigates the evil. Besides this the patent fuel does not clinker the tube ends—a matter of vital importance.

During the run down to Gravesend the small quantity of smoke given out was borne down and away from the tops of the funnels by the fierce head wind, and now and then a heavy spray broke on the bows, wetting everything forward. In the engine-room preparations were made for taking indicator diagrams. No attempt was made to drive the boat fast, because high speeds are prohibited by the river authorities on account of the heavy swell set up. The measured mile in the Lower Hope is on the southern bank of ths river, about three miles below Gravesend. Just as the boat passed the town, in the midst of a heavy rain-squall, the stokehole hatches in the deck were shut, and the dull humming roar of the fans showed that the fires were being got up. The smoke no longer rose leisurely from the funnels. It came up now with a rush and violence which showed the powerful agency at work below. A rapid vibrating motion beneath the feet was the first evidence that the engines were away full speed. As the boat gathered way she seemed to settle down to her work, and the vibration almost ceased. The measured mile was soon reached, and then, in the teeth of the northeaster, she tore through the water. The tide and wind were both against her. Had the tide and wind been opposed, there would have been a heavy sea on. As it was, there was quite enough; the water, breaking on her port bow, came on board in sheets, sparkling in the sun, which, the rain-squall having passed, shone out for the moment. As the wind was blowing at least 30 miles an hour, and the boat was going at some 26 miles an hour against it, the result was a moderate hurricane on board. It was next to impossible to stand up against the fury of the blast without holding on. The mile was traversed in less than 2½ minutes, however; but the boat had to continue her course down the river for nearly another mile to avoid some barges which lay in the way, and prevented her from turning. Then the helm was put over, and she came round. There was no slacking of the engines, and astern of her the water leaped from her rudder in a great, upheaved, foaming mass, some 7 ft. or 8 ft. high. Brought round, she once more lay her course. This time the wind was on her starboard quarter, or still more nearly

aft. The boat went literally as fast as the wind, and on deck it was nearly calm. The light smoke from the funnels, no longer beaten down by wind, leaped up high into the air. Looking over the side, it was difficult to imagine that the boat was passing through water at all. The enormous velocity gave the surface of the river the appearance of a sheet of steel for 1 ft. or more outside the boat. Standing right aft, the sight was yet more remarkable. Although two 6-ft. screws were revolving at nearly 400 revolutions per minute almost under foot, not a bubble of air came up to break the surface. There was no wave in her wake; about 70 ft. behind her rose a gentle swelling hill. Her wake was a broad, smooth, brown path, cut right through the rough surface of the river. On each side of this path rose and broke the angry little seas lashed up by the scourging wind. Along the very center of the brown track ran a thin ridge of sparkling foam, some 2 ft. high and some 20 ft. long, caused by the rudder being dragged through the water. There was scarcely any vibration. The noise was not excessive. A rapid whirr due to the engines, and a rhythmical clatter due to the relief-valve on one of the port-engine cylinders not being screwed down hard enough and therefore lifting a little in its seat at each stroke, made the most of it. The most prominent noise, perhaps, was the hum of the fans. Standing forward, the deck seems to slope away downward aft—as indeed it does, for it is to be noted that at these high speeds the fore foot of the boat is always thrown up clean out of the water—and the whole aspect of the boat, the funnels vomiting thin, brown smoke, and occasionally, when a fire-door is opened, a lurid pillar of flame for a moment; the whirr in the engine-room; the dull thunder of the fans, produce an impression on the mind not easily expressed, and due in some measure, no doubt, to the exhilaration caused by the rapid motion through the air. The best way to convey what we mean is to say that the whole craft seems to be alive, and a perfect demon of energy and strength. Many persons hold that a torpedo boat is likely to be more useful in terrifying an enemy than in doing him real harm, and we can safely say that the captain of an ironclad who saw half a dozen of these vessels bearing down on him, and did not wish himself well out of a scrape, has more nerve than most men.

The second mile was run in far less time than that in which what we have written concerning it can be read, and then the boat turned again, and once more the head wind with all its discomforts was encountered. Events repeated themselves, and so at last the sixth trip was completed, and the boat proceeded at a leisurely pace back again to Poplar. Mr. Crohn, representing Messrs. Yarrow on board, and all concerned, might well feel satisfied. We had traveled at a greater speed than had ever before been reached by anything that floats, and there was no hitch or impediment, or trouble of any kind.

The Italian Government may be congratulated on possessing the two fastest and most powerful torpedo-boats in the world. We believe, however, that Messrs. Yarrow are quite confident that, with twin-screw triple expansion-engines, they can attain a speed of 26 knots an hour, and we have no reason to doubt this.

The description of this remarkable boat and its trial trip are taken, as above noted, from the *Engineer;* for the accompanying illustrations, showing the general design and arrangement of the boat, we are indebted to *Engineering*.

The Bussey Bridge Accident.

THE Massachusetts Railroad Commissioners have issued an elaborate report on the accident on the Dedham Branch of the Boston & Providence road on March 14 last, commonly known as the Bussey Bridge accident. This report gives a summary of the evidence taken, a history of the bridge and comments, and gives also views of the wreck and drawings of the bridge. The report does not add much to what has been already published on this accident; the most important part is the summary and the recommendations, which are given in full below, with some of the statements as to the cause of the accident:

THE CAUSE OF THE DISASTER.

The testimony of the passengers, of the employés on the train and of two outside witnesses, shows conclusively that the trouble originated on the north half of the bridge, and the evidence, as a whole, clearly indicates that the original cause of the disaster was the breaking of the hangers at the joint-block at the north end of the Hewins truss In this view the counsel of the corporation and the experts, including the expert employed by the corporation, concur. These hangers were found in the street, and were examined by several people, including one of the Commissioners, on the morning of the accident. They were broken, the upper loops with part of the shank remaining in the joint-block, and the lower loops with the remainder of the shank lying near by.

One hanger was broken through the shank, and about seven-eighths of this break was old. In the other hanger the lower-loop was broken on the side and at its junction with the shank. At the shank there were indications of an old break through about one-eighth of the sectional area. The hangers should have been die-forged. They were loop-welded, and the weldings were imperfect.

The eccentricity, so called, of these hangers was unnecessary. This eccentricity caused the strains to be transverse and unequally distributed. In consequence thereof, the hangers were for their work in the bridge not nearly as strong as the same amount of material would have been had they been properly designed. Portions of them, without making any allowance for the jar of the train, were subjected by each passing engine to strains approaching, if not in excess of, the elastic limit. The margin of strength, if any, was so small as to be inconsistent with safety. Iron will surely break if repeatedly subjected to a load which strains it materially beyond its elastic limit. The hangers were unfit for their work. The wonder is that they held on so long as they did. They had been breaking for some time. On the morning of the accident there was little more than the equivalent of one hanger left.

The theory that the disaster was due to a derailment of the train received no sufficient confirmation. On the contrary, the fact was abundantly established by the evidence that neither the ties on the embankment south of the bridge nor those on the south half of the bridge itself showed any signs of derailment. If a derailment occurred it must have occurred within a few feet of the joint-block at the north end of the Hewins truss.

A theory was also started at the investigation, that the disaster might have been caused by the dropping of a brake-beam between the ties, but the theory was not supported by the necessary evidence. If a brake-beam dropped at all it must have dropped within a few feet of the hangers. * * * *

SUMMARY AND RECOMMENDATIONS.

The conclusions which have been reached by the Board are as follows:

The contract for rebuilding the bridge in 1876 was made without proper examination as to the standing of the contractor.

Those who acted for the corporation in making the contract had not sufficient knowledge of iron-bridge building to enable them to pass intelligently upon the design and specifications.

The design and specifications for the bridge were not such as should have been accepted.

The bridge was constructed practically without superintendence on the part of the corporation, and the corporation neglected to preserve a copy of the specifications, drawings and strain sheets.

The tests of the bridge were not made in the presence of any one acting for the corporation who was qualified to judge of their value.

From the time of the construction of the bridge to the day when it fell, the railroad company had caused it to be examined by one man only, who, year after year, passed

over vital parts of the bridge without realizing that they were of importance. This man had been in the employment of the corporation for a long series of years, his trade was that of a machinist, he had not been educated as a civil engineer, and the management had abundant reason to know that he was not qualified, and had had no opportunity to qualify himself, to do the work assigned to him with reference to this bridge.

The series of tests of the bridge recommended by the Board in 1881 was not made.

In the erection and inspection of bridges the management of a railroad is bound to exercise the utmost care. Had such care been exercised, there is every reason to believe that the disaster would have been prevented. On the thirty-second page of the last the report ofCommission is the following: "The Board renews the expression of its belief that a preventible accideut is a crime."

Notwithstanding the repeated warnings of the Board, the spaces between the ties on this bridge were far too great for safety.

Notwithstanding the recommendation of the Board in 1881, no suitable guard-rails or guard-timbers were placed upon the bridge.

The Westinghouse automatic air-brake, a safety appliance remarkable alike for its simplicity and effectiveness and long ago approved and adopted by all the leading railroads, was not in practical operation on this train, neither was the train furnished with a sufficient number of brakemen to comply with the requirements of the statute.

The disaster and the facts which have been disclosed impose a great responsibility on the Board of Directors. It is their duty, by the most searching inquiry, to ascertain forthwith whether any other work has been done in a like negligent and incompetent manner,whether, in other matters, reasonable and well-approved precautious against accident have been ignored or neglected, and whether false economy has been practised and safety sacrificed. They should not rest until they have taken the most energetic measures, without regard to expense and without regard to persons, to correct the past and to insure better and safer management in the future. So far as relates to bridges, the directors have already caused a thorough expert examination to be begun. Fortunately there are but few bridges on the line.

In mitigation of the sentence of condemnation called for by the foregoing findings and in support of the hope that the history of the Bussey Bridge is exceptional, it must be remembered that from 1869, when the Board of Railroad Commissioners was created, up to the time of this disaster, a period of 18 years, there has been no train accident on the Boston & Providence Railroad which resulted in the loss of a life of, or even in serious injury to, a passenger.

The accident furnishes another proof of the necessity of abolishing the deadly car stove.

As bridges embody many possibilities of danger, it is proper that special means should be taken to secure careful, competent and faithful construction and a thorough and scientific examination of them by the railroads at regular intervals, followed by a thorough State inspection. The importance of such action is emphasized by the fact that the weight of engines and of the rolling-stock of railroads and of the loads carried has been increasing for many years. The weight of engines and rolling-stock has doubled within 20 years. Moreover, the speed of the heavy passenger express and through freight trains has also largely increased.

The examination made by the Board of Commissioners can at best be but cursory. There are over 1,000 bridges in the State, and no member of the Board, no matter what his scientific education may be, can, in addition to his other duties as Commissioner, make anything but a brief, partial and unsatisfactory examination of them. A proper inspection in behalf of the State would require, practically, the whole time of a bridge expert.

The Board recommend the passage of an act requiring every railroad, at least once in two years, to have a thorough examination of all bridges on its lines made by a competent and experienced civil engineer, who shall report in writing to the corporation and to the Board of Railroad Commissioners the results of his examination, his conclusions and recommendations. The reports should embrace such information in relation to the history and construction of each bridge, including detail drawings and strain sheets, as may be called for by the Board of Railroad Commissioners, and said Board should be authorized to employ a competent expert to examine such reports and make such further examination of the bridge structures as may be deemed necessary or expedient.

New York Harbor Improvements.

(From the New York *Times*.)

THE river and harbor improvement work in the vicinity of the city is at present going on somewhat slowly, owing to the fact that the last session of Congress did not result in adding to the appropriation for that purpose. The work, which is very diverse, is being carried on upon the unexpended funds remaining of the previous appropriation. It covers a wide area, however, and is of very general interest.

In the East River, ever since Flood Rock went first up into the air and then down into the water in October, 1885, the task has been simply one of dredging. It is somewhat different from mud dredging, however. The material to be removed consists wholly of broken rock, and the dredge is a huge grapple, shaped like a clam shell with iron fingers or teeth. It is lowered in an open condition to the bottom, and, once there, the span is equal to a stone of 15 ft. in length. Recently a 38-ton rock came to the surface in one haul—the largest result which any steam grab bag of the kind has ever produced. Only one dredger is now at work, the second contract being in progress. The first was for the removal of 30,000 cubic yards and was completed in last July. The second covered 50,000 yards, of which 30,000 have now been taken a way. The dredger has double crews and is at work night and day.

The results thus far consist in a 350-ft. channel across the reef, with a depth across the entire width of 18 ft. No wrecks have been known in Hell Gate since the explosion, where before they were of daily and, in fact, tidal occurrence. The estimated traffic passing through there is now $4,000,000 per day. All the ships from Newtown Creek and the refineries and other industrial enterprises in that vicinity go and come by that route, and 4,000-ton steamers, 350 ft. in length, are frequent passengers, where they were formerly unknown.

The work is by no means completed, however. To create a depth of 30 ft. across the whole reef will require the removal of 350,000 cubic yards. Flood Rock proper is still out of water, though the rock is broken up to a depth of 30 ft. Its removal is simply a question of dredging. The Nigger-Head Reef has a depth of 18 ft. at low tide. The Hen-and-Chickens also has a depth of 18 ft. and these two were the main obstructions. The Gridiron is almost bare at low tide, but the plans contemplate a uniform depth of 26 ft. at low tide over the entire area.

Over Frying-Pan Rock, a reef about 200 by 100 ft. in size 1,000 ft. north of Flood Rock, there is now a depth of about 18 ft., which is to be increased to the regulation limit. The process consists in excavating 6-in. holes with a steam drill, working in a dome which rests on the bottom. The hole is bored to a depth of 16 ft. and then blasted. The same plan of working from the surface has been pursued with Pot Rock, between Negro Point and Astoria. This is a reef about the same size as the Frying Pan, and originally had a depth of only 8 ft., which has, however, been increased to 24 ft. Negro Point is at the south end of Ward's Island. This reef is 300 ft. long and is about two acres in area. It will require to be mined and be subjected to the gentle suasion of 50,000 pounds of powder to destroy its present cohesiveness. When these various improvements are completed there will be a clean channel, 1,290 ft. wide and 26 ft. in depth, through that part of the East River which, in the whole previous history of American navigation, has been known only to be avoided. It is approximately estimated that $1,000,000 will cover the entire expense, and two years suffice for the

necessary time. As Congress will not reach the appropriation bill, however, until near the close of the next session, there is no immediate prospect that the work will be soon completed.

The Harlem River project, by which the North and East Rivers will be united through a channel 15 ft. deep, is in a promising condition. The Commissioners appointed to assess the damages and benefits have filed their report, and it has been accepted in Washington. The appropriation of $400,000 made by the Government some years ago for this work now becomes available. It was made with the proviso that the work should not begin until the Government had secured, without expense, the right of way, and it was to attain this that the Commissioners were appointed. The work will begin in a few weeks. There is a large amount of excavation to be done, as the proposed channel runs across two hills, each 50 ft. in height, and other upland of inferior altitude.

The improvements in the Raritan Bay Channel, through to South Amboy, are well advanced, but require further work. The Raritan River is being dredged on the plans contemplating a depth of 12 ft. as far as New Brunswick. There is only $26,000, however, with which to do the necessary dredging, and, where the river is wide, the diking to protect and preserve the dredged channel. The sum of $20,000 will be needed to complete the work. In Shrewsbury River it is proposed to make a 6-ft. channel to Red Bank and Branchport, the harbor of Long Branch. This requires $100,000, of which $10,000 are at hand. The Passaic, which it is proposed to deepen to 12 ft. up to Newark, will require $100,000, of which $26,000 has been appropriated. All of the work mentioned is under the general supervision of Walter McFarland, Lieutenant Colonel of Engineers, the New Jersey improvements being in charge of his assistant, Lieut. G. M. Derby.

The most important work now in progress is the deepening of the main bay channel. Proposals have been asked for the dredging of 1,000,000 cubic yards in the vicinity of Flynn's Knoll. The knoll is a shoal two miles long, west and north of the South Spit. Its present minimum depth at low tide is 23 ft. 3 in. It is proposed to make a channel 30 ft. deep and 1,000 ft. wide. A contract has already been let for deepening and widening Gedney's Channel to the degrees named, and this work is now in progress. Gedney's and what is known as the main channel are the means of approach for all the large sea-going vessels. Work is also in progress for the deepening of Buttermilk Channel from 22 ft. in places to 26 ft. uniformly. Gowanus Creek is to be dredged to a depth of 18 ft. up to the Hamilton Avenue bridge, and Newtown Creek to a depth of 18 ft. as far as the drawbridge.

Surveys are also in progress to ascertain the condition of the bar. This, contrary to a general belief, is not shallowed by the detritus from the rivers and bay, but by the action of the ocean currents. The work employs a tugboat and a rowboat and is carried on in very much the same fashion as land surveying. Two tripods between 40 and 50 ft. in height, are planted and serve as transit stations, a transit and its operator being placed on each. Each sounding point is thus located and the depth measured. The work has not advanced far enough to give definite results as to the general changes in the bar since the last survey. Favorable weather is a prime necessity in the work, and available days have not been numerous for some time. If the weather continues pleasant, and the water sufficiently calm, results can be announced in about two weeks more.

The Gogebic Iron Ore Mines.

(From the *Engineering and Mining Journal.*)

THE Gogebic Range iron ore mines are certainly the most important mineral development of recent times. In the three years since the first mine was discovered, the opening of mines has proceeded at a marvelous rate; but the extent of the ore-bodies opened is scarcely less remarkable than the rate at which the ore has been extracted.

The Gogebic Range extends in a northeasterly and southwesterly direction for a distance of perhaps 30 miles, about half of which is in the State of Michigan, and the other half in Wisconsin. The ore is found, as has been many times described in these pages, in lenses of two, more or less parallel, so-called veins, which are in general from 300 to 400 ft. apart and dip to the northwest, conformably with the country rock, and at an angle which varies from 50° to 70°. These ore bearing zones are called the South and North veins, a designation which answers very well, though, in connection with the illustrations that have been published, it may give the erroneous impression that the ore is continuous in each vein over the entire length of the range. As a matter of fact, the ore occurs as lenses in these "veins" or ore zones, and these lenses, while dipping to the northwest with the general dip of the vein and country-rock, have also a dip to the east in the vein. If this page were the vein dipping north at an angle of say 65°, the top and bottom of the page representing horizontal lines, then an ore body or lens commencing at the upper left hand corner, would cross the page from left to right (southwest to northeast), at an angle of 30° to 40° with the horizontal line. The degree of this dip, thus generally stated, has not been accurately determined, though it is recognized in every mine yet opened, and probably varies between the figures given.

This northeasterly flat dip of the ore lenses in a vein which has a general dip to the northwest, is a point of considerable importance in some cases, for it may quickly carry large ore-bodies out of any given property where they outcrop near its eastern boundary.

The ore-bodies in the north vein appear to be much less regular and well defined than those in the south vein. Indeed, at the Colby Mine, where both veins are worked extensively, the ore-body in the north vein appeared at a very moderate depth to be cut off, but upon investigation was found to be in the foot-wall in an irregular mass, with pieces of the foot-wall rock jutting out into the ore in the most capricious manner; and though probably nearly 100,000 tons of ore have been extracted from this vein, it is yet uncertain whether, the ore-bodies in the north and south veins may not meet in depth. The intervening rock, which was more than 300 ft. in thickness on the surface, is scarcely more than half this thickness at a depth of 150 ft.

And yet the extreme irregularity in the north ore-body of the Colby mine and in its foot-wall, in connection with the remarkable parallelism of the finds of ore on the surface in the two veins, appears to indicate that the rock between the ore bodies is not merely a "horse," which will give out in depth and bring the ore-bodies together, but that these lenses occur in two separate zones, though in places, as in the Colby Mine, the north ore-body, which has there an abnormal thickness, may have replaced a portion of the quartzite and jaspery slates which separate the two veins or ore zones.

The very origin of these deposits precludes the idea that the north and south ore-bodies can be considered as parts of the same vein, with simply a "horse" of rock between.

As already stated, the ore is collected in lenses in the ore-bearing zone, and these lenses are of all sizes, from a few feet in length and thickness to masses which have, in a few cases, been proved continuous in horizontal length for nearly or quite 1,000 ft., and that swell out in places to a proven thickness of from 150 to even 200 ft. of 60 to 63 per cent. ore. These lenses occur at intervals in the ore zone: sometimes they lie in echelon, one overlapping the other, and separated by but a few feet (usually at the present depth) of a soft talcose rock known locally as "soap rock," and sometimes they are separated by a considerable thickness or length of hard jaspery slates.

The iron ores of the Gogebic Range are generally soft hematites, or sesquioxides of iron; but occasionally hard ore is found, and in some cases even the radiated or needle ore.

These "veins" lie conformably between a quartzite, or metamorphosed sandstone, foot-wall, and a siliceous jaspery slate top or hanging wall. The ores, as well as their surrounding rocks, are undoubtedly of sedimentary origin, and were probably deposited originally as carbonate

of iron—somewhat similar to the carbonate deposits at Burden, on the Hudson River—and they have since been altered or metamorphosed until in this district they are soft hematites, and in the Marquette Region are hard magnetic or specular oxides.

Though their very origin renders these ore-deposits more uniform and permanent than many others, yet it must not be expected that workable ore will be found at all points in the "veins," or that they will be found of equal quality at all depths. In some cases, to which we shall hereafter refer, large bodies of clean shipping ore have been found to commence at the very grass roots, while more frequently the ore near the surface is more or less mixed with bands of jaspery slates and other rock, and is too silicious to be marketable. In these cases the ore has very frequently improved in depth, becoming less mixed with rock. No doubt this improvement has been so general as to justify, in a measure, the general expectation that a find of "mixed ore" may lead to a body of clean ore in depth; but the rule is far from being universally true, and the expectation that all occurrences of mixed ore are only the caps or tops of clean ore-deposits, is not only not to be relied on, but it is not so generally the case as those whose fortune depends on the acceptance of the theory would, very naturally, have one believe.

In short, the value of each particular property depends on its own developments, and those on adjoining ore-bodies which will enter it; on the position of its ore-bodies with respect to its boundary lines; on the quality of its ores, and on the cost of mining and putting them in market, including the royalties or ground rents to be paid. Most of these are questions for expert determination.

Every important investment in this, as in every other, mining district should be guided by expert advice; but we shall, in referring more particularly to the several mines along the range, give some pointers, which may serve as general guides in estimating values.

That these are now in many cases grossly exaggerated, every one who investigates their foundation can easily see; but the fact that the Gogebic Range possesses a very considerable number of magnificent mines, and that vast fortunes have been made in booming Gogebic stocks, prepares, or should prepare, every one to expect the floating of worthless property, and the vast exaggeration of the values of some of the good mines.

The Iron Ore Belt of Minnesota.

(From *Science.*)

The annual reports of state surveys are, for the most part, dull reading, especially for non-residents; since they are necessarily of a detailed and fragmentary character, showing the progress of investigation in many different directions, with very little completed work. The reports of the geological survey of Minnesota for 1884 and 1885, however, embody material of more than local interest, and it is desired to call attention here to those portions, without attempting to notice the entire contents of the volumes.

The notes on the section from Duluth north to the iron mines about Vermilion Lake give Professor Winchell's latest views concerning the stratigraphy of the crystalline rocks of Northeastern Minnesota, between Lake Superior and the international boundary. The height of land between Lakes Superior and Vermilion is marked by two distinct ranges—the high and broad Mesabi Range, composed of eruptive gabbro and red metamorphic granite; and, north of this, the lower and narrower Giant's Range, consisting of gray and red syenites, which have been referred to the Laurentian, and mark an important anticlinal axis. North of this axis, and dipping north at high angles, is a broad belt of the green and red jaspery and magnesian schists and conglomerates referred to the Huronian. South of the axis, the Huronian series appears to be concealed by a fault; but we have above it, dipping to the south in conformable succession, the Animikie slates and quartzites, the gabbro and granite of the Mesabi Range, and the greenish trap of the cupriferous series, extending from the Mesabi Range to Lake Superior.

The gabbro, Animikie and Huronian series are each characterized by important deposits of iron ore; and this district is, with almost phenomenal rapidity, assuming a position of the first importance as regards the products of its mines. The iron of the gabbro belt is, as usually with rocks of that class, titanic. It furnishes the iron-sand of the Lake Superior beach, and, so far as known, has no parallel in Michigan and Wisconsin. The iron ore of the Animikie slates is hard hematite and magnetite, and probably parallel to the Commonwealth Mines of Wisconsin, but without any known equivalent in Michigan, while the Huronian deposits, occurring chiefly about the south end of Lake Vermilion, consist almost wholly of hematite, and seem to agree closely in character and position with the Marquette and Menominee deposits of Michigan and Wisconsin.

The Vermilion Lake Mines are being rapidly exploited, and the discovery of these ore bodies is regarded as marking an epoch in the economic history of Minnesota and the Northwest.

The salt wells of Northwestern Minnesota and the adjacent portions of Dakota and Manitoba are believed to give promise of important developments; and various facts are cited tending to show that, although the occurrence of carboniferous strata in this region has not been heretofore definitely known, these brines, like those of Michigan, really have their source in that formation.

Sir William Armstrong on Swift Cruisers.

On Saturday afternoon (April 9), in the presence of more than 100,000 spectators, the monster armor-clad war vessel *Victoria*, the heaviest ever successfully floated, was launched from the Elswick shipyard of Sir W. G. Armstrong, Mitchell & Co. (limited). The following are the dimensions of the vessel: Length 340 ft., breadth 70 ft. 6 in., mean draft 26 ft. 9 in., displacement in tons 10,500, horse-power 12,000. She is protected by armor 18 in. thick, and will be armed with two 110-ton guns, twelve 6-in. guns, and about 90 smaller guns. The *Victoria* also possesses a powerful torpedo attack. She glided into the water gracefully, after having been christened by Mrs. Forwood, wife of the Secretary to the Admiralty, Mr. Forwood, M.P. Lord Charles Beresford was present, and also Mr. W. K. White, Chief Constructor of the Navy.

Sir William Armstrong first proposed the toast of "The Queen," and it was heartily responded to. Sir William next proposed the toast of the day, "Success to the *Victoria*." He said that she was not only the first armor-clad the company had ever built, but was the heaviest ship that had ever been successfully launched in this country. The Admiralty seemed disposed to slacken their expenditure upon these gigantic vessels and to expend their operations in the building of swift cruisers, and he had always said that what England wanted above all things was a numerous fleet (hear, hear) of swift cruisers, not extemporized out of passenger boats or merchant ships, but built and especially adapted for the purpose for which they were intended—for the protection of our widespread commerce, and for aiding in the defense of our colonies. Now, for the purpose of comparison between the ships of the present day and the ships of the past, he could take no more fitting example than the *Victory* of the old time and the *Victoria* of to-day. Nelson's ship, the *Victory*, was one of the largest of her time, and yet her displacement, with everything on board, was only 3,500 tons. That of the *Victoria* of to-day was 10,500 tons. The *Victory*, in accordance with the usage of her time, was built of oak. The *Victoria*, in accordance with the usage of our time, was built of iron. The *Victory*, of course, depended entirely upon the wind, while the *Victoria* was dependent upon steam. The speed of the *Victory* under the most propitious conditions was barely 13 knots an hour; while the *Victoria*, propelled by her engines of 12,000 horse power would probably reach a speed of 17 knots per hour. The heaviest gun on board the *Victory* was under three tons, while the largest gun on board this vessel would be 110 tons. The largest and heaviest shot used on board the *Victory* at Trafalgar was 68 pounds; the largest and heaviest on board the *Victoria* would be 1,800 pounds.

The weight of metal delivered from the *Victory's* broadside was only 1,150 pounds, while that delivered from the broadside of the *Victoria* would be 4,760 pounds. In point of range, artillery penetration, shell power and so forth, the difference was so enormous that a comparison could not be drawn. The armament of the *Victoria* would be two guns of 110 tons firing ahead and on either side, one gun of 30 tons firing astern and on either side, 12 guns of 5 tons each in an armored battery, 12 6-pound quick-firing guns, and 9 3-pound quick-firing guns, besides machine guns for smaller ammunition; and in addition to her artillery she had a powerful ram and eight torpedo discharges, four above water and four below. In the days of the *Victory* a little ram was the practice and torpedoes were wholly unknown. Therefore, they could have no comparison in that respect. Another point on which the *Victoria* compared most favorably with the *Victory* was in the smallness of the number of men the *Victoria* would need to handle her. The complement of the *Victory* was 850 officers and men. The *Victoria* was three times as big, and the number of men required was only 550, and, of that number, 110 were engineers and stokers. It was then impossible to work the armament of the big guns now in use. Hydraulic power was now used. Sir William proceeded to argue that the large amount of money spent upon the navy was not lost, but was beneficial to the nation at large in many ways, and he resumed his seat amid loud cheers. *London Daily News.*

Fifty Years of Yacht Building.

[Abstract of paper read before the British Institution of Naval Architects, by Mr. Dixon Kemp.]

THIS paper reviewed the changes in this branch of shipbuilding during the past half century, tracing the effect of the departure from old theories.

The few yachts above 20 tons in existence in England 50 years ago were modeled after brigs, schooners or cutters of the Navy. The brigs especially were about the size of those of the Navy, but were considered superior in sailing qualities. One of the best known was the *Waterwitch*, built by Joseph White, of Cowes, in 1832. This brig had a great reputation for speed and weatherliness, and beat H. M. S. *Pantelon* about 4 miles in a 6 hours' sail to windward. The *Waterwitch* was bought by the Admiralty, and subsequently Mr. White built other brigs for the Navy, notably the *Daring*. This vessel and the *Waterwitch* performed the best to windward in a strong wind and head sea in the experimental sailing of 1844.

The cutter rig was so superior in point of weatherliness, the author claimed, that its adoption for almost all yachts intended for racing was a matter of natural selection. Between 1815 and 1837 there was seldom any time allowed for difference of size, and the result was that, with any kind of breeze, the largest vessel came in first and won. As there was no tax of any kind on any of the dimensions, there was no inducement on that score to alter the proportions of length, breadth and depth from the prevailing Navy type. These proportions were from 3 to 3½ beams to length of water-line, and the greatest transverse section was placed ahead of the middle of the length, by a distance varying from one-tenth to one-fiftieth of the length. The center of buoyancy was generally situated at about the center of length, and it appears to have been an aim of the designers to keep the displacement of the fore-body and after-body equal. The upper horizontal water-lines of the bow were short and full, and the load water-line aft was generally full, but the buttock or vertical lines were long and flat. The *Fair Rosamond* schooner of this cod's-head type was designed by Mr. Fincham, and built in 1846 by Mr. Campe, of Gosport, for the late Duke of Marlborough. Mr. Fincham stated that the center of buoyancy of the *Fair Rosamond* was .004, in terms of the length, abaft the center of length, and that she would have performed better in a head sea had her center of buoyancy been farther forward. In 1847, he designed the *Novice* schooner for the Earl of Desart, and placed her center of buoyancy .01—9 in.—ahead of the center of length. There is no doubt that Mr. Fincham was much mistaken in attributing so much subtle influence to slight variations in fore-and-aft positions of the center of buoyancy. About this time the theory of the late Mr. John Scott Russell—that the bow should be longer than the stern—began to be accepted as nearer the truth than the old theory of the cod's head; and, in the year 1847, whilst Mr. Fincham was designing the *Novice*, a very remarkable vessel was built on the Thames as an exponent of Mr. Scott Russell's theory. This was the *Mosquito* cutter of 59 ft. water-line and 15 ft. 4 in. beam, built by Mr. Mare, of Blackwall, and launched in 1848. The *Mosquito* was like one of the cutters of the period turned end for end; her bow was long, and showed considerable hollow, and her after body was short, showing great fullness both in the horizontal and buttock lines. Her midship section was placed 4 ft. 6 in. abaft the center of length of water-line, and her middle of buoyancy was 2 ft. abaft it. According to the old practice, the *Mosquito* should have had no good qualities at all, especially in strong winds; but the fact is, she excelled in all the good qualities claimed for the bluff-bowed craft; she was faster than any other yacht of her length, on any point of sailing, and, in a strong wind to windward, was a marvel compared with other yachts. However, so strong was the prejudice against the "long, lean bow," and so alarming the predictions—that some day the *Mosquito* would take a dive and never come up again—that no one could be found to try the experiment on a more extensive scale. It thus seemed likely that the old type would be continued in spite of the *Mosquito* having, in a superior degree, all the good qualities it was contended a yacht should have.

So far as can be learned, the first American yacht race took place just 50 years ago, and it does not appear that any yachts existed in the United States before 1835, and those built subsequently, up to the year 1844, were small schooners. In the year named, however, a remarkable vessel was built in Hoboken, named *Maria*, on the lines of the flat-bottomed coasters. She was 100 ft. on the water-line, with an extreme beam of 26 ft. 8 in., and draught aft of 5 ft. 3 in. She was fitted with a center-board which dropped 16 ft. below the keel, and also had a small one aft to prevent her griping. She had a long hollow bow, and was sloop rigged, with jib and mainsail only. The foot of her mainsail was 92 ft. long, and the foot of her foresail or jib, 70 ft. This vessel may be said to have been the original of the American center-board yacht; but, although she showed extraordinary speed and weatherliness, there appears to have been a conviction that more depth of body and less beam would be better for good sea-going qualities. At any rate George Steers—the son of a Devonshire shipwright who had settled in New York—produced the keel yacht *America*, which was destined to have such an important influence on British yacht building and sail-making. In the *America* the principles so successfully carried out in the *Mosquito* were embodied with equal success; she had a long and somewhat hollow bow, a short run, and the center of buoyancy was considerably aft of the middle of length, as will be gathered from the accompanying table :

	Mosquito. Feet.	*America* Feet.
Length on water line	59.2	87.3
Breadth, extreme	15.3	22.2
Draught of water, extreme	11	11.5
Proportion of beam to length	0.257	0.254
Midship section aft center of length in terms of length of L. W. L	0.076	0.071
Center of buoyancy ditto	0.032	0.041

The *America* visited us in 1851, and achieved a remarkable success at Cowes over our schooners. This success was, no doubt, mainly due to the qualities of her hull, but the unusual flatness of her sails contributed greatly to her fine weatherly qualities. The immediate effect of the *America's* success was rather startling; almost every yacht in existence at that time was lengthened by the bow, her masts raked, and sails laced to the booms; and the principles which had been so strikingly exemplified in the *Mosquito* three years before were now adopted as a new discovery of infallible merit. This marked the commencement of a new era in yacht designing, and the subsequent development of yachts into the now fashionable type has shown no considerable departure from the principles observed in the design of the *Mosquito.*

As soon, however, as yacht racing became a general summer pastime, a rating for size became a necessity, and the size test adopted was simply the registered tonnage of the day, or what we now know as builders' measurement, which took no account of depth, but assumed that it always equaled half the breadth. Frequent competition, and the teachings of investigators of naval science, impressed yacht builders very forcibly with the fact that the element of size which gives speed is length ; and that if two yachts were of equal tons, but one should happen to be longer than the other, then the longer boat would be certain to prove the faster, all other things being equal, such as sail spread, stiffness and fairness of lines, etc. Or if two vessels were of equal length and one measured fewer tons than the other, then her rating would be smaller, and she would receive a compensating time allowance. Although lead keels had some years previously—about 1846—been introduced as a means of increasing stiffness, after shifting ballast to windward during match sailing had been abolished ; but up to 1870 no yacht was to be found with more than about a tenth of her ballast on the keel, and the majority had none at all. A better knowledge of the good effect of concentrating the ballast in the middle third of the length of the vessel rapidly led to a larger quantity of lead being placed outside, until at last the whole ballast was placed outside on the keel. This lowering of the ballast, and consequently of the center of gravity enabled the designer to dispense with a considerable quantity of breadth and add to the length for any given tonnage, until, in some of the smaller yachts, the length has been equal to 6½ beams, and in the larger, 5¾ beams The power to carry an effective quantity of canvas in narrow yachts has not, however, been entirely due to placing the ballast outside; for any given nominal tons the displacement has been largely added to this. These large additions to the displacement, whilst the power for getting through a head sea may have been increased, have had a prejudicial effect on the attainment of high speeds, mainly on account of the enormous wave-making it induced. Thus, so recently as 1880, the *Arrow* has been driven in strong winds as fast and sometimes faster than the *Formosa* or *Samœna*, and with very considerably less wave disturbance. The lead keel of one of these long, narrow yachts, it should be explained, is in breadth about one-third of the main breadth of the vessel, and in weight is equal to about 0.5 of the total weight of vessel in a yacht like the *Galatea*, to 0.7 of the total weight in a 3-tonner. The Americans did not much alter this center-board type of yacht and keel yacht during the period between 1845 and 1885. Accordingly, when, in 1885, the owner of the British cutter *Genesta* challenged for the cup won by the *America* at Cowes, in 1851, the Americans set to work to produce a compromise yacht, but distinctly more American in type than British. This yacht, in section, was of the broad V character—very like the *America* of 1851—with almost twice the draught of water that the ordinary shallow center-board yacht had. Beyond this she had nearly the whole of her ballast outside, in the form of a lead keel, supplemented by a center-board of considerable area. This yacht was named *Puritan*, and, so far as can be judged, she defeated the *Genesta* on her merits. The same fate befel the *Galatea* last year, the Americans having built another yacht of this new type to meet her.

Triple-Expansion Engines.

(From *Engineering*.)

An interesting table has been compiled to show the difference in the fuel consumption of a number of steamships, part of which had compound and part triple-expansion engines. The results of the working of 11 compound and 9 triple-expansion engines are given in the table which was attached to a paper recently read at the Northeast Coast Institution of Engineers and Shipbuilders, by Mr. J. P. Hall. The paper was an attempt to discover the relative value of the two kinds of engines "from a shipowners point of view," and after dealing with the questions of space, of wear and tear, and of the life of the different kinds of boilers, the writer dealt with the very important question of fuel consumption. The vessels, whose performances are given, are of the cargo-carrying type, many of them built by the company (Palmer's Shipbuilding & Iron Company, Limited) Mr. Hall is connected with, and where this is not the case he considered that the facts were equally to be relied on. Care was taken to select voyages where the weather was "reasonably fine, and as nearly as possible uniform." The tables are thus arrived at : The "consumption is taken at a speed of 10 knots, either increased or reduced, on the assumption that the power or coal varies as the cube of the speed," and the consumption tables are thus brought to the speed of 10 knots with 1,000 tons weight, and 1,000 knots steamed, for simplicity in comparison. Thus tested, the 11 steamers fitted with compound engines had a consumption of 19.748 tons on the displacement performance, whilst the 9 triple-expansion engined steamers had a consumption of 14.859 tons on the displacement performance. On the deadweight performances the compounds had a mean consumption of 30.481 tons, and the triple-expansion engines one of 22.744 tons. Thus the saving on the average of the vessels is 24.75 per cent. on displacement performances, and 25.38 per cent. on the deadweight performances. Mr. Hall gives in his table a number of instances in detail out of which these averages arise, one of which, being a comparison between two vessels owned by the same firm, and under the same superintending engineer, of similar size and speed, as well as on the same voyage (from Liverpool to Bombay and back), may be thus given :

Consumption of Coal per 1,000 Tons carried per 1,000 Knots.

Displacement Performance.		Deadweight Performance.	
Result.	Saving in favor of Triple.	Result.	Saving in favor of Triple.
tons.	per cent.	tons.	per cent.
18.892		29.555	
	22.72		21.65
14.598		23.156	

Several other instances are given, but as they are like that above included in the general summary and result it is needless to quote more.

The Gandak Bridge.

(From the *Indian Engineer*.)

The first proposal to bridge the Gandak River at its present site was brought forward in March, 1883, or just four years ago. The idea was that the several systems of meter-gauge lines north of the Ganges should be connected with each other. These systems were mainly three : the Bengal & Northwestern Railway, the Tirhoot State Railway, and the Northern Bengal and connected State Railways. The obstacles to through communication between these three systems of lines were mainly the two great rivers, the Gandak and the Kosi, which drain Nipal, and, after emerging through narrow gorges in the lower ranges of the Himalayas, rush with great and destructive velocity across the clay plains of Behar and Bengal to join the Ganges, the Gandak near Patna, and the Kosi between Bhagulpur and Sahibganj. The very early importance of the town of Patna, which was known to ancient Greek and Chinese travelers, must, in all probability, be largely ascribed to its situation at the junction of two great natural river highways. Mighty streams which were formerly aids have now, however, become obstacles to traffic, as is evidenced by the number of big bridges which are being rapidly erected all over India, not the least important of which is that over the Gandak.

The general tendency of the bulk of the produce of the Northwest Provinces, Behar and Bengal, is to seek

European markets through the port of Calcutta. There is, however, a considerable interchange of produce between the different districts, the conditions of which vary considerably owing to such disturbing causes as soil, climate or labor supply. Thus, while the produce of the Northwest Provinces or of Tirhoot, which seeks the port of Calcutta, can advantageously be brought on to the East Indian Railway at Patna and Mokameh, respectively, by the Bengal & Northwestern and the Tirhoot railways, it was considered necessary, in the interests of the local inter-district trade in sugar, tobacco, rice, etc., as well as for the economical working of the railways themselves, that they should be connected by a bridge across the River Gandak.

The Secretary of State's sanction was, therefore, obtained to its erection, and the first commencement of work was made in October, 1884. The bridge has now been completed, and was opened March 30, 1887. It has, therefore, occupied less than 2½ years in erection.

Under the general title of Gandak Bridge are included 3⅓ miles of railway, connecting the Sonpur terminus of the Bengal & Northwestern Railway with the Hajipur terminus of a branch of the Tirhoot State Railway. These 3⅓ miles of line contain five minor bridges and culverts, as well as the main bridge.

The river, where spanned by the bridge, is about 2,000 ft. wide, with a bed of exceptionally troublesome running quicksand, which is always liable to alteration with every few inches change of level of the river. Floods are known to rise to a height of 22 ft. At one point of the bed of the river, solid ground is only reached at a depth of 80 ft. beneath the surface of the quicksand.

The bridge consists of eight spans of 250 ft. each, resting on piers, which, by means of the usual Indian system of wells, have been sunk into the quicksand and solid clay to depths varying from 40 to 90 ft. The abutments have been founded in the solid ground at a depth of about 30 ft. below the surface of the bank. The girders contain altogether about 2,500 tons of steel and iron, the steel in one girder being 190½ tons.

The length of the bridge, inclusive of the abutment, is 2,100 ft. The 3⅓ miles of railway, which include the bridge, will cost about $714,000, out of which about $500,000 represents the cost of the bridge itself.

Great difficulty was experienced in traversing the valuable grove of timber usually occupied by the Sonpur Fair, without taking up too much ground; this difficulty was got over by the construction, within the limits of the Fair ground, of an arched viaduct, nearly half a mile long, the arches of which will be used as shops during the Fair. In return for the use of these arches, the land upon which the viaduct stands has been given free by the owners.

Since the commencement of the work it has been carried out under the orders of Mr. Horace Bell, Superintending Engineer in the Public Works Department, the Manager and Engineer-in-Chief of the Tirhoot State Railway. Mr. R. A. Way, Executive Engineer, has been in immediate charge of the work since soon after its commencement, when it was, for a short time, in charge of Captain Kunhardt.

Hydraulic Cement.

It must be admitted that the general distribution of chemical knowledge in all branches of the engineering profession is creating a vast revolution in our ideas and playing sad havoc with many time-honored institutions. In few cases is this more clearly shown than in the incessant—we had almost written wearisome—discussions and quibblings now going on in many of our scientific contemporaries anent the relative merits of various artificial hydraulic cements employed for the purposes of construction. And yet the question as to what should be the composition and qualities of a good cement really seems to us to lie in a nutshell, when we remember that, roughly speaking, it is actually prepared by calcining, until near the vitrification point, the purest obtainable calcium carbonate with about 22 per cent. of its weight of ordinary clay. During the process, the carbonic acid gas is totally expelled, there is formed a combination of silicates and aluminates of lime, $SiO_3 3CaO + Al_2O_3 SiO_3 CaO$, and this calcined mass, being ground to an absolutely impalpable fineness, is transformed, under the influence of moisture, into hydrated double silicates and aluminates, upon which water is powerless to exercise any action.

The best conditions for good cement manufacture are doubtless fulfilled in regions possessing readily available quantities of pure limestone and river clay, containing small percentages of iron and various alkalies. Failing these, pure chalk and ordinary clay will generally answer all purposes; but it will be necessary in their case to introduce into the mixture, before it is kilned, about 1 per cent. of common salt. From the point of view of successful manufacture, however, it is most essential to maintain unvarying quality and proportion in the materials employed. And this can easily be accomplished by chemical analysis. From the consumer's standpoint, the most necessary precaution, after the analysis and trials of its breaking strain, is to guard against the unfortunate and too common practice of using a cement directly from the sacks instead of first spreading it upon a clean and dry surface and allowing it to remain for a couple of days exposed to the action of the elements of the air.

If, however, chemical analyses were more frequently resorted to by manufacturers, and allowed to take the place of "rule of thumb" methods, we should soon hear no more of "cement" containing free lime or free magnesia, for it is very evident that a compound, possessing either, is devoid of the very virtues which of all others it is intended to possess and is not cement at all.—*Engineering and Mining Journal.*

Accidents on East Indian Railroads.

(From the *Indian Railway Service Gazette.*)

The return of railroad accidents in India for the third quarter of 1886 rather dissipates the idea that mishaps are few and far between in this country. Altogether there were 678 accidents of various descriptions in the three months, the number being slightly below that for the corresponding period of the previous year. The East Indian shows a decrease of 18, the Rajputana-Malwa of 22, the Southern Mahratta of 15, the Great Indian Peninsula of 26, and the Bengal & Northwestern of 21. On the other hand, there were 16 more accidents on the Jorhat, 12 on the Madras, 20 on the Oudh & Rohilkhund, which is not perhaps to be wondered at, and 20 on the Assam. Cattle seem to have been responsible for a considerable proportion of the total casualties. On the Madras Railway there were 19 accidents owing to animals wandering on the line, on the Oudh & Rohilkhund 39, on the Great Indian Peninsula 8, on the Rajputana-Malwa, 43 (or 15.69 per cent. of the total of 274), and on the Bengal & Northwestern, 6. The number of cases in which passenger trains or parts of them left the rails decreased from 30 to 21, or by nine, owing, it is noticed, to there having been no mishaps under this head on the Bengal & Northwestern and the Eastern Bengal railways, against nine and three respectively in the corresponding quarter of 1885. In the number of cases in which goods trains, parts of them, or engines left the rails, there was, however, an increase from 58 to 84, nine more accidents of this kind occurring on the Northwestern Railway, 6 more on the Cawnpore-Achnera State Railway, 7 more on the Jorhas State Railway, and 11 more on the Assam Railway. It i noteworthy that during the quarter under review not a single casualty of this description occurred on the Bengal & Northwestern line, although there were 14 in the corresponding three months of the previous year. There were 19 cases of the bursting of tubes of engines, 61 of the failure of machinery and springs of engines, and 36 of the failure of couplings. The number of cases of flooding of portions of the permanent way was largest on the Great Indian Peninsula, which returned 8 out of a total of 31. Under this head there was a decrease on the Rajputana-Malwa and Northwestern from 13 to 9 and 14 to 7 respectively. The cases of slips in cuttings or embankments show the satisfactory decrease of 17 to 3, owing

chiefly to no accidents of this description occurring on the East Indian Railway. The cases of fire in trains were most numerous on the Northwestern, the number being 13 (or 65 of the total), but as compared with the corresponding previous quarter there was a decrease of 4 on the line, and the total for all India shows a decrease of 12.

Coming to casualties to passengers and others, we find that 111 persons were killed and 202 injured through causes connected with the working of trains. Sixteen more are reported to have been killed and 49 injured in yards and workshops, and 130 to have met their deaths in carriages and at stations from causes unconnected with the working of trains. From causes beyond their own control, 1 passenger was killed and 10 injured, whilst from misconduct or want of caution 7 were killed and 36 injured. Among servants, the numbers were 3 and 18 and 41 and 115 respectively. Two persons were killed and 2 injured whilst passing at level crossings, and 49 were killed and 17 injured while trespassing on the line. Six people committed suicide, and 2 more were killed and 4 injured from miscellaneous causes.

Electric Street Railroads in Europe.

[From the *English Mechanic*.]

THERE can be no doubt that if it were not for the red tape which hampers every enterprise in this country we might by this time have had more practical experience of the utility of electric locomotion than we can obtain from the successful experiments at Blackpool, Brighton, and at Port Rush in Ireland. In the United States electric tramways are at work in many of the larger cities, and preparations are being made for widely extending the new method of traction: while on the Continent of Europe there are at least three tramway schemes which are not only practically but financially successful. So long ago as May, 1881, an electric tramway was opened near Berlin, and traffic has been regularly carried on during the six years, without a mishap of any importance, although the average speed is 12 miles an hour. The line has always been regarded more as an experiment than as a type to be permanently adopted, and for that reason cars with different kinds of gearing have been tried, not for a few months, but in regular work for several years in order to test the durability of the mechanism adopted. It is well known that to obtain a high degree of economy an electric motor must run with great velocity, which must be greatly reduced by the time its motion is transmitted to the driving axles of a tramway car; methods of doing that form the subjects of several patents, and it may be that the best arrangement has not been devised. In a highly interesting paper on the subject read last week before the Society of Arts by Mr. Reckenzaun, a gentleman practically acquainted with all the minute details of electric locomotion, the author said it seems an easy thing to the uninitiated to reduce 800 revolutions of one shaft to 80 of another; but when it has to be done in connection with a tramcar, a vehicle on which space is limited, noise objectionable, and dirt and dust in abundance, one obstacle after another crops up to disappoint the inventor who imagines he has solved the problem. On the Berlin-Lichterfeld line one of the cars has run 76,000 miles since the opening, and has pulleys on the motor-shaft and car axles with V-grooves in which run cords of spiral steel wires. The cords are made by winding a pair of wires closely on a mandrel rather less than ⅛ in. in diameter, so that the finished cord is a flexible spiral having an external diameter of barely 7-32 in. This device, it seems, works without noise or vibration, though some little difficulty is experienced in adjusting the cords upon the pulleys; for if too tight they will break at the joints, and if too loose slip at starting—not a disadvantage, as that is the most trying moment in all gearing driven by electro-motors. Other devices are employed, such as the pitch-chain, but the spiral cords seem to be the best. On Mr. Volk's line at Brighton, belts made of leather links are used; the armature shaft, with a 5-in. pully driving a countershaft with a 24-in. pulley, from which the belt is taken to the driving axle. The belts slip a little at starting, but that eases the motor; while, if necessary, the countershaft being carried in adjustable bearings, the belts can be made as tight as desired. The expense per car mile of this line, the prime mover of which is a gas-engine using gas at 3s. 3d. per 1,000 cubic feet, is only 2d.—a figure which is below that which Mr. Reckenzaun gives as possible when the most efficient machines are employed —viz., 3d. The Brighton arrangements are, however, scarcely suitable for ordinary tramcar traffic, as there is no mud to contend with, and the ordinary rails serve as conductors of the current. It should also be noted that each car last year made no fewer than 23,475 miles, and but for opposition in certain quarters the Brighton electric tramway would be a success in every sense of the term. Of lines worked by overhead conductors the most carefully constructed, if not the most important, is that arranged on the plan of Messrs. Siemens and Halske at Mödling, near Vienna. It is nearly three miles in length, and, like most other tramways in Europe, does nine-tenths of its traffic between April 1 and the end of October, the average cost being 3.42d. per car mile. The average speed permitted is a little over nine miles an hour, and the conductors are slotted tubes carried on posts 18 ft. high and 90 ft. apart, except on sharp curves. The bore of these tubes has to be made perfectly smooth, so as to offer but little resistance to the passage of the contact carriage, which consists of a flexible piece of flat steel carrying three gun-metal pistons made in halves, with springs in the middle, so as to keep the surfaces of pistons and conductor in contact. The pistons require renewal about every two months. Overhead conductors are, however, scarcely suited for electric-tramway work, except in country districts, such as the line just referred to, or that between Frankfort-on-Main and Offenbach, which is 4.1 miles long, and has the slotted overhead tube, and a contact carriage made up of two solid iron pistons, which require renewal every three or four weeks at a cost of one shilling for each carriage. Both the Mödling and the Frankfort cars have spur gearing, and the experience gained with them is not favorable to the further utilization of that means of connecting the motor shaft with the driving axles. For instance, in the Frankfort cars a pinion of 17 teeth on the motor shaft gears into a wheel of 56 teeth on a countershaft, and a pinion of 26 teeth on that drives a wheel of 52 teeth on the axle of the car, giving a ratio of about 6.6 to 1 between the motor and the car wheels. The motor, however, runs at the comparatively low speed of 500 hundred revolutions per minute, and the whole arrangement is heavy, for the train of wheels weighs about 4 cwt., and the total weight of the driving gear for one car is more than 26 cwt. The gearing produces so much noise and vibration that the sensation experienced in the car is anything but agreeable, and the wear and tear are so great that the pinion on the motor shaft wears out in a month, although made of hard gunmetal. Mr. Reckenzaun says that one of the cars is being fitted with wheels having double helical teeth, which are expected to work more smoothly and be more durable; but it may be doubted whether any difference in the shape of the teeth will render toothed gearing tolerable, although it should be mentioned that nearly one million passengers patronized the Frankfort electric tramway last year in spite of the disagreeable noise made by the gearing. On the Port Rush line, the longest electric tramway in the world, pitch-chain gearing is used, and is stated to work satisfactorily, as it does also on the Bessbrook-Newry line. Both these lines are worked by electricity derived primarily from water power, and the cost is respectively 3d. and 4d. per car mile, in the latter case including everything. Mr. Reckenzaun referred briefly to the Blackpool line, and mentioned the systems devised by Profs. Ayrton and Perry, and by Messrs. Pollak and Binswanger, the former having the third rail divided into sections, the connection with the main cable being made automatically by the train as it moves along; and the latter an altogether novel system, in which a powerful magnet under the car attracts, or is supposed to attract, an iron armature in a thoroughly insulated trough beneath

each rail section, which armature when attracted makes contact between the cable and the surface rail, and through the latter with the switch of the car motor. Both systems are ingenious and worth trial; but at present no opinion can be formed of their efficiency, as they exist only on paper. So far we have referred only to lines in which the current is conveyed from a central station to the car throughout the whole length of the tramway; but batteries carried by the car itself are a much earlier device, having been adopted so long ago as 1839, when, of course, they were too expensive, the secondary or storage cell not having come into knowledge then. In order to compare the two systems, Mr. Reckenzaun estimates the efficiency of the conductor and of the secondary battery in the following manner. Taking the tramway at Mödling, the conductor has 2 ohms resistan e, 20 ampères of current for each car, and 500 volts E.M.F, at the terminals of the charging dynamo, Supposing only one car running on the line, the waste of energy will be practically nothing at the commencement of its journey; but it will be $20^2 \times 2$ when approaches the furthest end of the line; the average resistance—that due to half the length of the conductor—is 1 ohm, therefore the average loss is only $20^2 \times 1 = 400$ watts against $500 \times 20 = 10{,}000$ watts generated by the dynamo, or a loss of 4 per cent. With six cars on the line equally distributed, however, using 120 ampères, the loss will be 14,400 watts out of 60,000, or 25 per cent.; and so by increasing the number of cars and the current the efficiency becomes less and less. With the accumulators the loss is constant, no matter how long the line, provided the quantity of the stored energy is sufficient for the time, and it matters not how many cars run at the same time on the tramway. The weight to be propelled would be increased, which would entail a corresponding augmentation of power, and therefore a greater consumption of fuel would be the result. But fuel really plays a small part in the total expenditure, and viewed from the standpoint of convenience the propulsion of tram cars by means of secondary batteries is the best system that can be adopted, especially in towns, because it leaves the permanent way in its present simple state. Whether each car should carry its own battery and motor, or an electric locomotive should be used for hauling cars, will depend on circumstances. So far as the neighborhood of London is concerned, it appears that the electric locomotive will be the first system tried, for trips have already been made with the Elieson locomotive on the Romford road out of Stratford, and we presume they will soon be put into regular work. The locomotives and the secondary batteries are ready, and, but for the roundabout ways of Parliament, would have been conveying passengers and earning money long ago. These locomotives weigh, ready for work, about 7 tons; what they will do in the way of hauling cars remains to be proved, but there is not much doubt that they will be cheaper than horse-flesh, and it is certain that they will leave the road as clean as they found it—a point which should not be forgotten in comparing the respective merits of horse and mechanical traction. Sufficient has already been done to show that the cost of electric tramways need not exceed 4d. per car mile, while horses cost from 7d. to 10d.; so that, taking the lowest estimate, there is a saving of one-half, and probably when experience has enabled managers to strike out items which can be dispensed with, the economy may be still more.

As to the gearing for transmitting the power, Mr. Volk believes in the linked leather belts, but Mr. Reckenzaun and others consider the worm arrangement the best; on this point the mechanicians will have something to say, for, if electric tramways are to be introduced, the noise and vibration caused by the gearing will not long be permitted to remain an objection. It may be that the spiral wire cords used for a time on the Berlin line will be found the best arrangement; but it is certain that spur gearing will not do, because, however smoothly it may run when new, it rapidly deteriorates and soon makes so much noise as to be objectionable. There are, however, many methods of transmitting motion which are free from noise, and which only wait an opportunity to assert their superiority in this case.

Formulæ for Weights of Bridges and Depth of Trusses.

THE formulæ given below were presented in a paper read before the American Society of Civil Engineers by Professor A. J. DuBois; in that paper they are supported by an elaborate train of reasoning, and are supplemented by tables calculated on the basis of the formulæ and giving weights, depth of truss, etc., for a number of cases:

DU BOIS FORMULÆ FOR WEIGHTS OF BRIDGES.

For railroad bridges take weight of rails, ties, planking, etc. = 400 lbs. per lineal foot for single track.

Weight of plate girder in pounds =

$$\frac{12\,Wl^2 + 2\,Rld^2}{1.2\,Rd - 12\,l^2} \qquad (1)$$

Here l = span in feet, d = depth in inches, R = average flange stress in pounds per square inch. W = total external load in pounds including allowance for impact.

Economic depth in inches =

$$\frac{10\,l^2}{R} + \sqrt{\frac{6\,W\,l}{R} + \left(\frac{10\,l^2}{R}\right)^2} \qquad (2)$$

Total weight of wind bracing = $N\,(540 + 3.6\,l)$.

Here N = number of panels. l = span in feet.

For bridge trusses:

W_1 = equivalent uniform load per foot per truss due to live load.

W_2 = load per foot per truss due to cross-girders, stringers, rails.

W_3 = load per foot per truss due to wind bracing.

W_4 = weight per foot of one truss, not including bed plates or rollers.

$$W_4 = \frac{W_1 + W_2 + W_3}{\dfrac{3.6\,\mu\,d}{A + \dfrac{\mu\,(45\,p^2 + 202\,a^2)}{(W_1 + W_2 + W_3)\,p}} - 1} \qquad (3)$$

Here d = depth in feet. p = panel length in feet. μ = the numerator of the strut formulæ used. A is found as follows:

For single intersection Pratt truss:

$$A = p^2\,(2\,N^2 + 3\,N - 2) + 3\,d^2\left(2\,N - 4 + \frac{11}{N}\right)$$

For double intersection Whipple truss:

$$A = 2\,p^2\left(N^2 + 3\,N - 10 + \frac{12}{N}\right) + 3\,d^2\left(N - 2 + \frac{16}{N}\right)$$

For Warren girder truss:

$$A = p^2\,(2\,N^2 + \therefore 5\,N - 2) + 6\,N\,d^2.$$

The formulæ for depth of truss is as follows:

Economic depth in feet =

$$\frac{l}{N}\sqrt{\frac{\alpha + \dfrac{45\,\mu}{(W_1 + W_2 + W_3)\,p}}{\beta + \dfrac{202\,\mu}{(W_1 + W_2 + W_3)\,p}}} \qquad (4)$$

The depth and weight of the cross girders and bracing can be found by formulæ 1 and 2.

Cruisers for China.—The Chinese Government has recently given an order for six new armed cruisers to a Hong Kong shipbuilding firm. It is not generally known that there are now several establishments in Hong Kong where vessels of 150 ft. long can be built in a substantial manner. The cruisers are to be about 100 ft. long and built for swiftness rather than for fighting qualities, and are for use in Chinese waters, where smuggling is ripe and flourishing owing to the excessive venality of the officials. Nearly all the material for these vessels will be imported from Great Britain.

Manufactures.

[Copyrighted by the Rogers Locomotive & Machine Works.]

THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

(Continued from page 229.)

Chapter V.

THE ENGINES.

CYLINDERS.

The first method of fastening outside cylinders was to bolt them to the smoke-box, which was made of sheet or plate-iron, when the cylinders were steeply inclined, as shown in fig. 17, page 45. This could be done without difficulty, but when they were placed lower down it was necessary to extend the smoke-box downward. The lower part was usually made rectangular in shape, as shown in fig. 140, with a heavy wrought-iron bar, *B B B*, riveted around the inside at the front end. The cylinders were then bolted to the outside of the smoke-box and to the frames *F F*, as shown in the engraving. This method of fastening was first used in 1844.

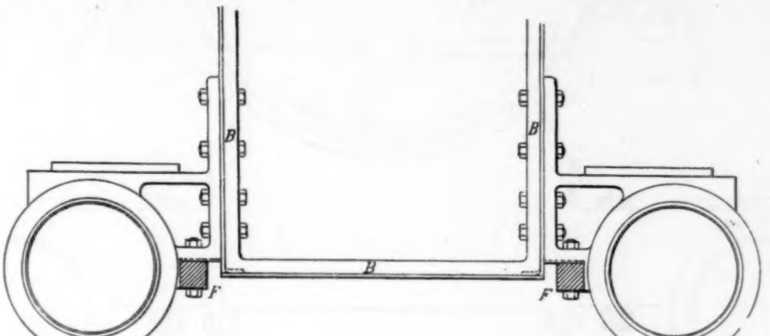


Fig. 140.

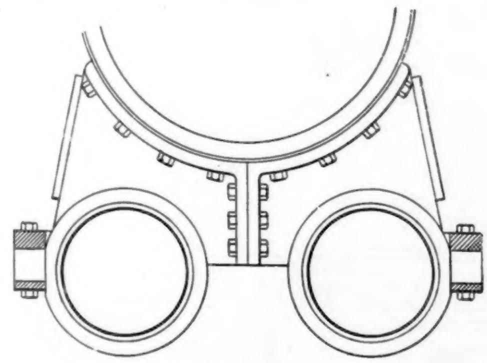


Fig. 141..

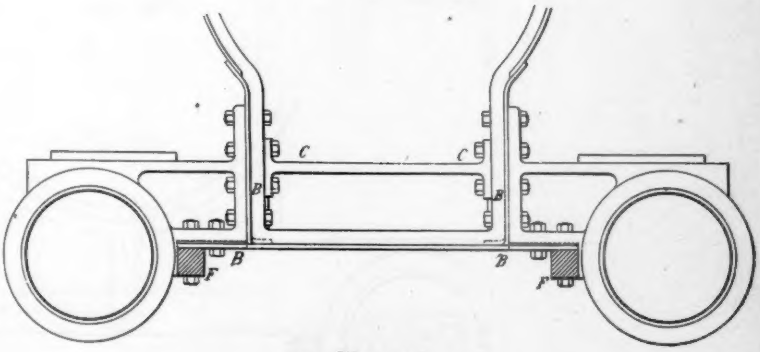


Fig. 142.

Inside cylinders were attached to the smoke-box and frames as shown in fig. 141.

The next step, which was taken in 1853, was to make the bottom *B B*, fig. 142, of the smoke-box of a heavy wrought-iron plate. This extended outward so as to rest on top of the frames *F F*. The cylinders were then placed on top of the plate and bolted to it, and to the smoke-box and frames, as shown. A bar, *C C*, with T ends was also placed crosswise between the bar *B B* to keep it apart and stiffen the whole attachment.

In 1865, the arrangement shown in fig. 143 was adopted. The smoke-box in this case was substantially like that shown in fig. 142, but a cast-iron bed, *E E*, was placed between the two frames *F F* and bolted to them by flanges. The smoke-box was then placed on top of the bed-plate and bolted to it. The cylinders were bolted to the bed-plate frame and smoke-box, as shown.

About the same time, the plan represented in fig. 144 was put in use. In this, the smoke-box was made cylindrical and a heavy bed casting, *E E*, with steam and exhaust pipes cast in it, was bolted to it by suitable flanges. The cylinders were then attached to the frames and to this casting, as shown.

In 1871, the plan shown in fig. 145 was adopted. The smoke-box was cylindrical, and one-half the bed-casting was cast with each cylinder. They are bolted together in the center, as shown. This plan is now almost universally used in this country and makes a very neat, strong and satisfactory job.

VALVES AND VALVE-GEARING.

The main valves which were first built by Mr. Rogers were of the ordinary D pattern, and the valve-gearing was a form of hook motion. In some cases, as shown in fig. 14 (page 44), the eccentrics were outside of the journals and wheels. Unfortunately there are no authentic drawings in existence of the various forms of valve-gearing which were at first used. At an early date, Mr. Rogers was impressed with the importance of using steam expansively, and, in 1843 and 1846, he designed and used the valve-gearing shown in fig. 146. It serves to show the thought he was giving at that date to the subject of working steam expansively.

Fig. 147 shows another plan, which he introduced in 1847.

When the link-motion was introduced into this country its use was violently opposed by many locomotive builders and master mechanics. Mr. Rogers was one of the first American engineers to recognize its merits. In 1849, he used the suspended link-motion, shown in fig. 148, for some engines for the Hudson River Railroad, and, in 1850, he applied the shifting-link motion, shown in fig. 149, to some engines which he built. It will be noticed that in this case the lifting-shaft was below the link. In the same year he designed the form of link-motion shown by fig. 150 for some ten-wheel engines, the front wheels and axles of which came in the way of the rocking-shaft. In this case the lifting-shaft was above the link.

Fig. 151 represents a combination of link-motion with an independent graduated cut-off valve. It was used on several locomotives built at the Rogers Works in 1854, and, it is said, was found to be beneficial in economizing fuel.

For many years the form of valve-gear shown in fig. 149 was used by Mr. Rogers, and, after his death, it was applied to many engines; but, in 1862, Mr. Hudson designed the form of link-motion shown by fig. 152, in which the lifting-shaft was placed above the link. This is the form which is now most commonly used. The link-motion shown by fig. 153 was also designed the same year by Mr. Hudson and applied to some

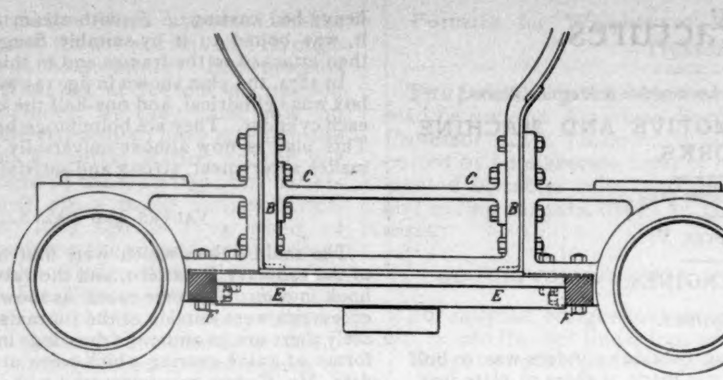


Fig. 143.

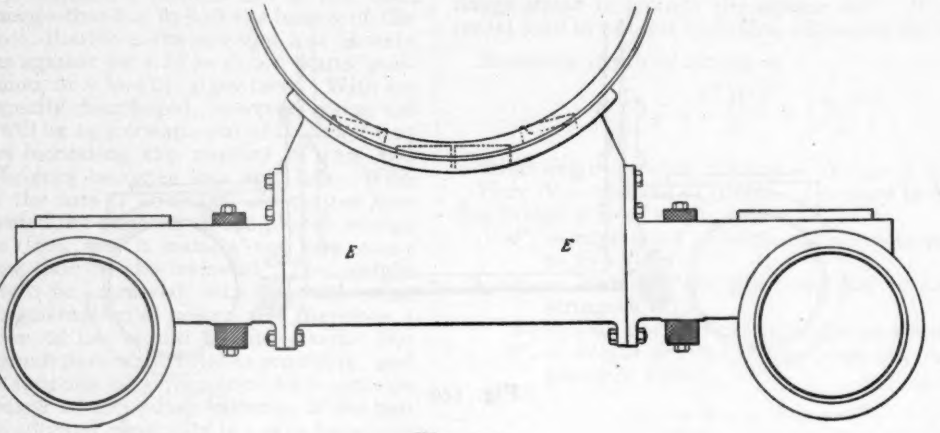


Fig. 144.

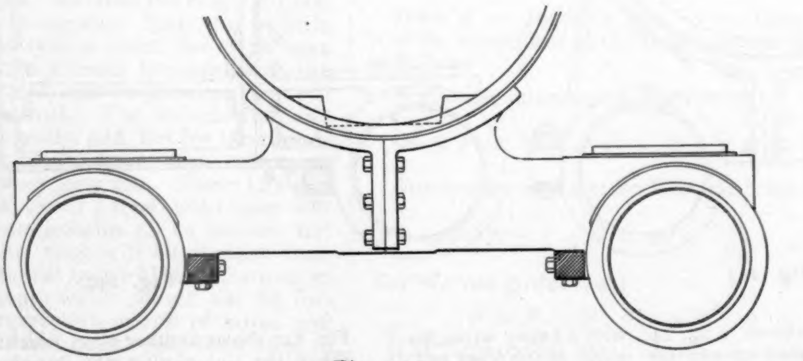


Fig. 145.

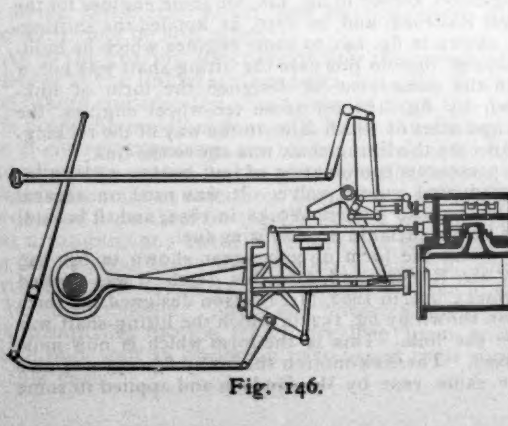


Fig. 146.

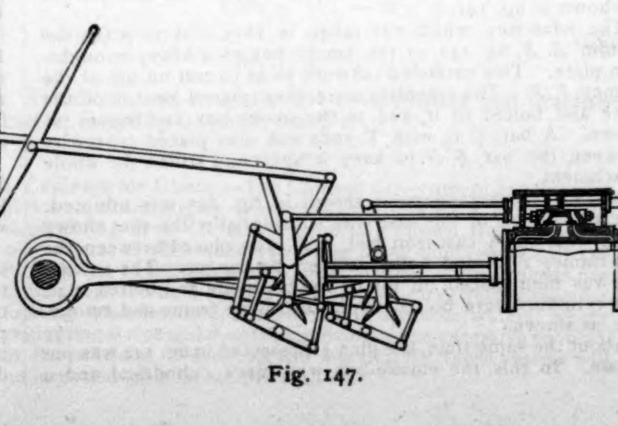


Fig. 147.

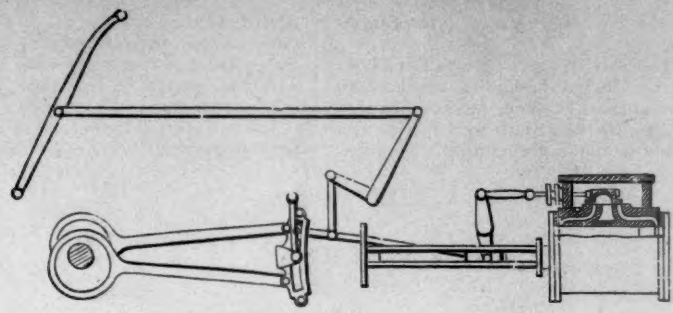
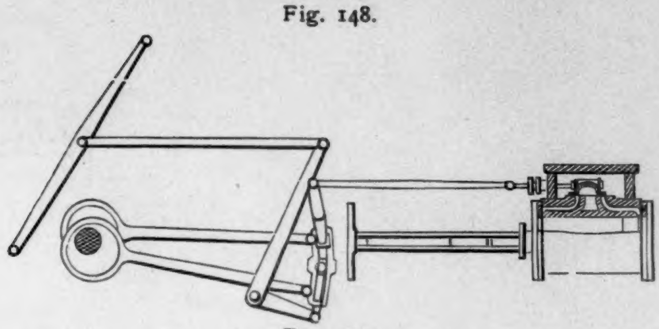


Fig. 148.



Frg. 149.

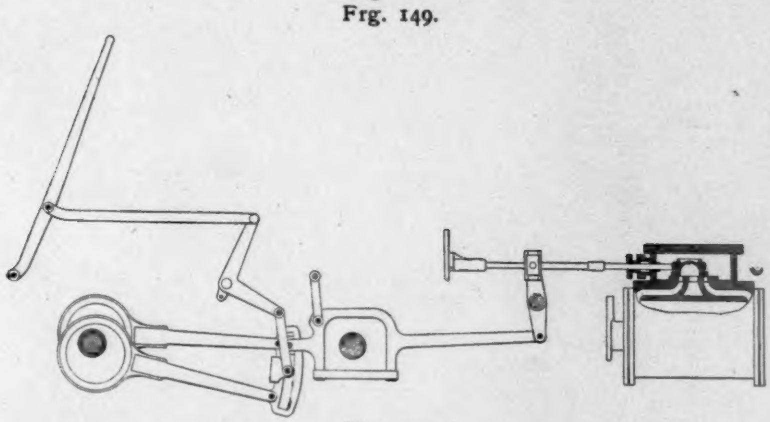


Fig. 150.

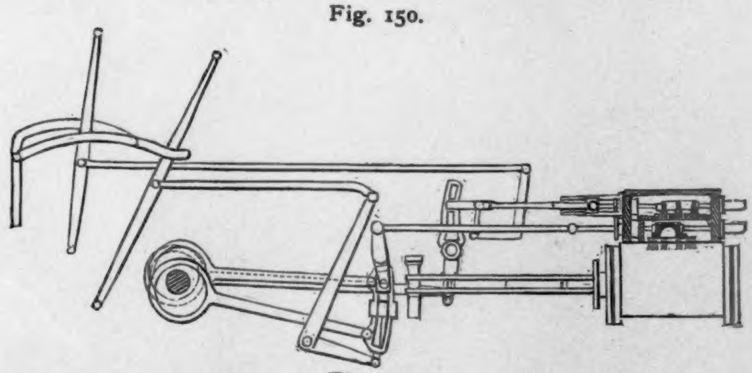


Fig. 151.

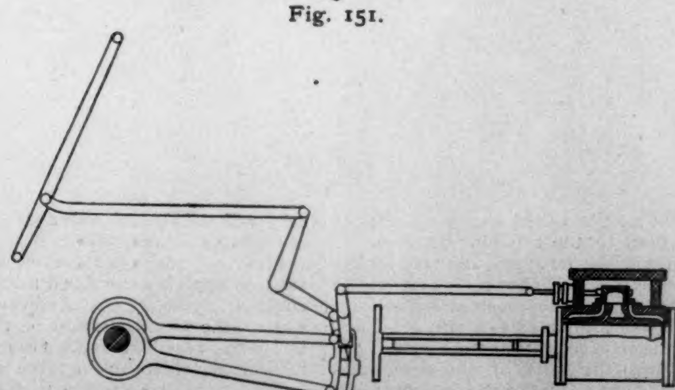


Fig. 152.

ten-wheel engines, in which the front wheels and axle came in the way of the rocking shaft.

In 1866, the valve-gearing shown in fig. 154, which was designed and patented by Messrs. Uhry & Luttgens, was applied to an engine for the Central Railroad of New Jersey. In this there is an ordinary shifting-link worked by two eccentrics and connected with a pin attached to the lower arm of a rocking-shaft in the usual way. What may be called a supplementary rocking-shaft, *R R'*, was pivoted to the top pin of the main rocking-shaft. The lower arm *R'* of the supplementary rocking-shaft is bent into a half-circle, as shown, in order to clear the main rocking-shaft *M*. The supplementary rocker is worked by a cam, *O'*, which was connected to a pin, *P*. The effect of the action of the cam is to accelerate the movement of the valve at the time that it opens the ports for admission and exhaust. Its adjustment is the same as that of the link-motion, and, at the higher grades of expansion, it gives about 50 per cent. greater opening of steam port. The point of exhaust is retarded from 5 to 6 in. beyond the link-motion, while the point of compression remains the same. The size of opening of the exhaust-port is somewhat larger than with the link-motion, and it is opened in less time, thereby producing a strong and clear exhaust.

Its objectionable feature is the cam as a mechanical device for locomotives. Whether this objection would be as great if used with a balanced valve as it is with an ordinary slide-valve remains yet to be proved.

Figs. 155 and 156 show the methods which were adopted in 1873, in applying the Allen link-motion to some narrow-gauge engines for the Patillas Railway, S. A., in which the front axle was in the way. Ordinarily, the Allen link is made straight, but in this case Mr. Hudson found that it would not give a satisfactory movement to the valve without curving the link slightly.

Fig. 157 shows another method of applying a link-motion to engines in which the front axle was in the way. This was used in 1881

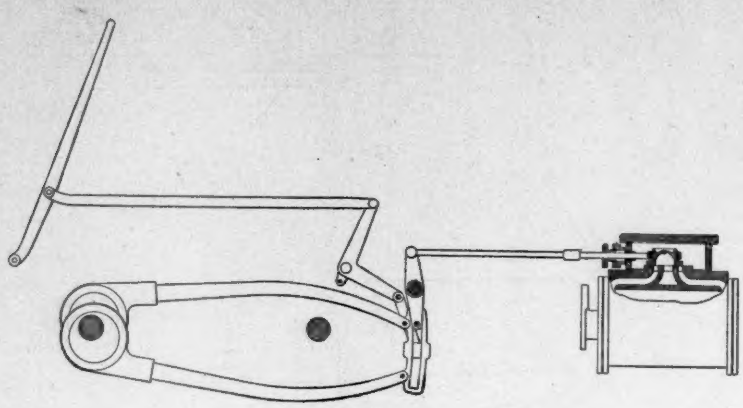


Fig. 153.

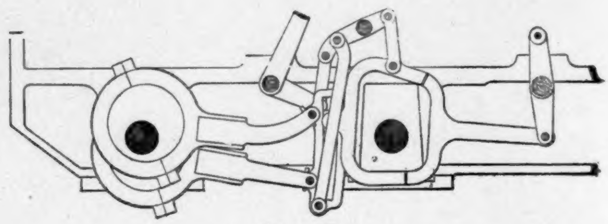


Fig. 155.

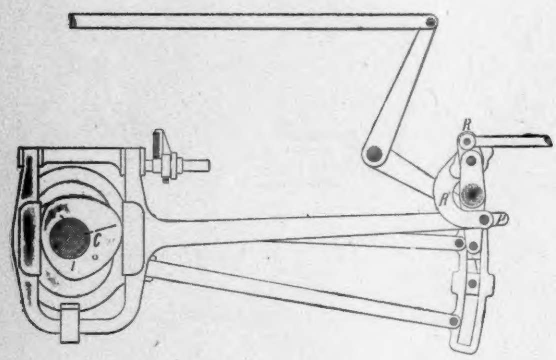


Fig. 154.

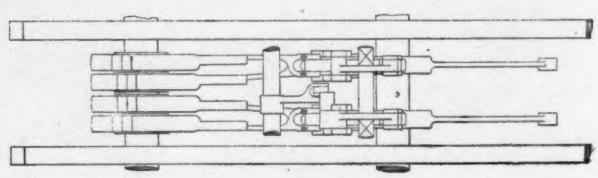


Fig. 156.

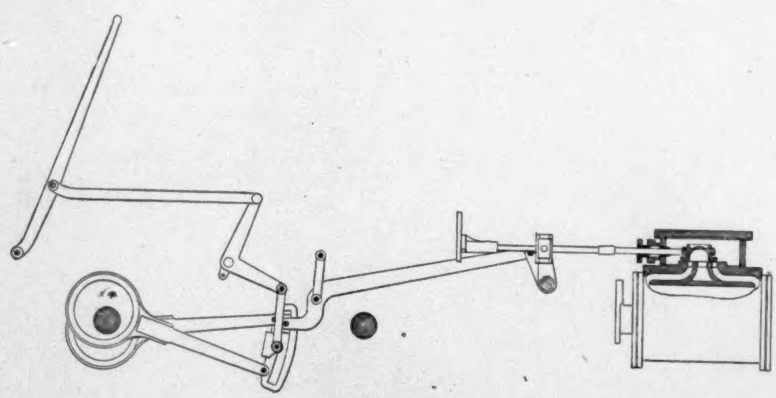


Fig. 157.

COUNTERWEIGHTS FOR LINKS.

When shifting-links were introduced it became important to counterbalance their weights so as to lessen the effort required to move them. The arrangement shown in fig. 158 was adopted in 1858. In this the counterweight *W* was attached to an arm or bell-crank forged on the reversing lever.

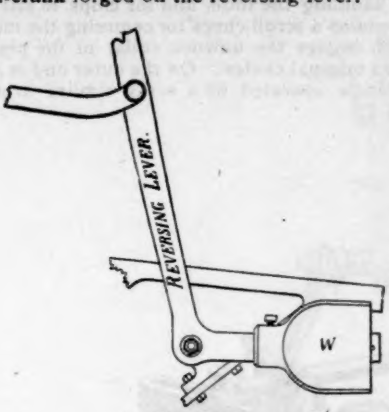


Fig. 158.

The unwieldy character of a counterweight led to the substitution of springs of various forms. The plan shown in fig. 159 was adopted in 1859. In this a half elliptic spring, *S'*, which was attached by its ends, *A A*, to fixed parts of the engine, was connected by a rod, *R*, to a short arm, *B*, which was keyed on the lifting-shaft by a strap, *S*, as shown.

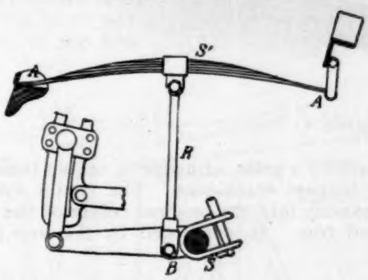


Fig. 159.

Another plan of applying a semi-elliptic spring is shown in plan in fig. 160. In this case the spring *S* was connected to a short arm, *B*, forged on the middle of the lifting-shaft.

In 1860, a spiral spring, figs. 161 and 162, was used. The inner end of this spring was attached to the lifting-shaft *S'*, and the other end was fastened to a case in which it was en-

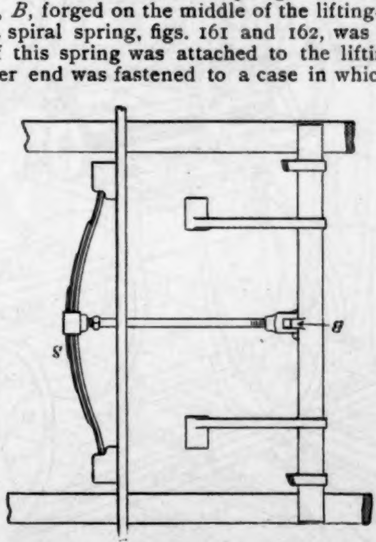


Fig. 160.

closed. The case was prevented from turning by a bolt, *B*. The required amount of tension was brought on the spring by turning the case, and the bolt was adjusted in any one of the holes, which were arranged in a circle, as shown in the engraving.

In 1873, a pair of volute springs was substituted for the semi-elliptic spring. These volute springs are shown in fig. 163. They were enclosed in a case and fastened by a bolt, *B*, to one of the cross-beams, and were connected by a rod, *R*, to a short arm on the lifting-shaft, like that shown in fig. 160. In this instance the rod *R* was subjected to a compressive strain by the tension of the two volute springs.

Fig. 164 shows a helical spring, which was applied in 1875 for the same purpose. This was also enclosed in a cylindrical

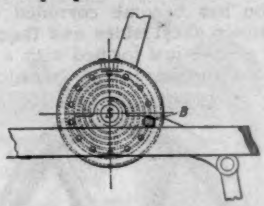


Fig. 161.

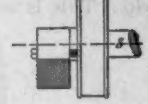


Fig. 162.

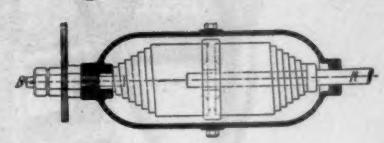


Fig. 163.

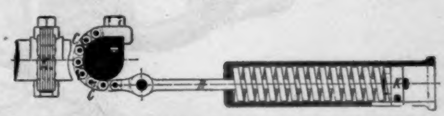


Fig. 164.

case, which was fastened to a fixed part of the engine. A chain, *C C*, was fastened at one end to the shaft, and wound around it as shown. The other end was attached to a rod, *R*, which was screwed into a collar, *K*. When the shaft was turned the spring was compressed. Its tension could be adjusted by means of the screw-end on the rod so as to balance the weight of the link.

(*To be continued.*)

The Miltimore Machine for Dressing Car Wheels.

A NEW machine for dressing and truing up car wheels has been devised and constructed by Mr. George W. Miltimore, of Arlington, Vt. It is based on the principle that a wheel of comparatively soft metal, if moved at very high speed, will wear away the hardest surfaces. The Miltimore machine, as arranged for car wheels, has a disk or wheel, the outer portion of soft steel, 40 in. in diameter and with a face corresponding in shape to the tread of the wheel. This disk is mounted on a shaft 6 in. in diameter and is run at about 2,100 revolutions per minute. The car wheel to be trued up is held in a frame in which it revolves slowly and is fed up to the disk by a combination of friction wheels and screw-feed. The shaft on which the disk is carried is lubricated by means of a pump, which forces oil to the journals at a pressure of about 40 lbs. to the square inch. The disk itself has a wrought iron center, with a screw-thread cut on the surface; the outer portion or tire, of soft steel, is a ring 2 in. thick, with a screw thread cut on the inside, and is screwed upon the center.

It is claimed that in this machine wheels can be trued up very quickly, and also that the tread is made very hard, a skin or surface being formed which resists the wear of the rails and brake-blocks to a remarkable degree. The advantages gained by truing up chilled wheels are too well known to require any enumeration here.

The soft steel rim of the disk wears very slowly, and it is even said that it increases in size by the accretion of melted particles from the wheels.

An exhibition of one of these machines was given at the factory in Arlington, Vt., recently, a number of railroad officers and wheel-makers being present. At this, steel-tired wheels were trued up in from 7 to 17 minutes, according to the hardness of the tire, while chilled wheels were trued up in from 7 to 10 minutes. The speed of the work depends somewhat, of course, on the amount of power used. It is claimed that a wheel can be dressed in five or six of its own revolutions in the machine.

The machine can, of course, be used for dressing any metallic surfaces by proper arrangement and the use of disks of the proper shape.

Special Tools for Railroad and Repair Shops

(Continued from page 182.)

PORTABLE STEAM-CHEST SEAT MILLING MACHINE.

IT is customary, in order to secure a tight joint for the steam-chest when the iron has become corroded to cut a groove the width of the steam-chest sides and then to drive into or fill up the recess or groove just formed with a brass or copper strip. This is a slow and expensive operation, and it is next to impossible to make an even and true surface for the brass or copper joint to rest upon, when using the only accessible tools, *i. e.*, the chisel and file. The portable steam-chest seat milling machine shown in fig. 10 is designed to do this work perfectly, by hand or power, and without skilled labor. It is also adapted to drilling new holes for studs or drilling out old studs when broken off; it can be used as well for milling out the ports on new work and for repairing the same when eaten away.

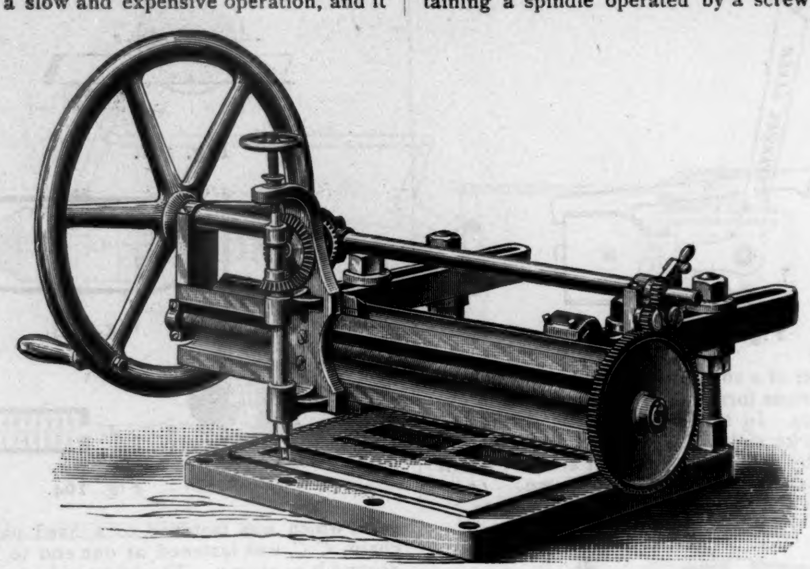


Fig. 10.

STEAM-CHEST SEAT MILLING MACHINE.

The machine is supported and adjusted to the surface to be grooved or milled by four studs running through two hollow arms, which, in turn, support the V's or slide. This slide carries a head containing a spindle similar to a drill press, and this head receives a transverse movement by means of the screw, as shown, the milling spindle being driven by beveled gears and a transverse shaft.

The cutting or grooving is performed by a face-milling cutter inverted in the end of the spindle, which is fed up and down by means of a screw and small wheel, and, when the proper depth for a cut is reached, the horizontal movement of the spindle is prevented by means of a check-nut on the small screw. The sliding or tool-head is fed in either direction by means of change feed-gears at the end of the screw, and, in case of drilling a hole or milling down to the desired depth of a groove, the head can in a moment be made independent of the transverse feed-screw, while the spindle is rotated by the driving-shaft.

It will be seen that advantage has been taken of the limited space afforded for this work in the construction of the machine, and that the strain on the tool-head slide and supporting arms has been reduced to a minimum by bringing the bearing for the spindle within half an inch of the face of the work, thus practically lowering the entire machine as far as possible. But two settings or adjustments of the machine are required for all four sides of the steam-chest seat, because, when the groove is finished on the outer side of the valve-face, all that is required is to loosen the top nuts on the studs supporting and passing through the arms, lift up the machine and replace it facing the boiler, when, having been secured, work can be resumed. The same applies to the other sides, the forward and back ends; after it is set for one and the cut finished, the machine is turned about and replaced on the same studs.

But one size of the machine is built, as provision for very large steam-chest seats is made by supplying extension feet or plates fitted with a T-slot and hole for the ordinary stud.

Fig. 11 shows the machine located on the valve-seat of a locomotive, where it is operated by hand.

The machine shown in figs. 12 and 13 is designed for truing up crank-pins when they are cut or worn unevenly. It consists of a casting bored out to receive a revolving cutter-head which carries the tool for the turning; sufficient space is allowed for handling the tools and for chips to fall out. The large end contains a scroll chuck for centering the machine, the jaws of which engage the unworn collar of the pin-centering machine to its original center. On the outer end is a disc containing a spindle operated by a screw similar to a lathe tail stock; this allows a great adjustment, taking in the shortest as well as the longest crank-pins. The center containing the spindle fits exactly into the original center of the pin, holding the outer end true. It is fastened by the four-jawed scroll-

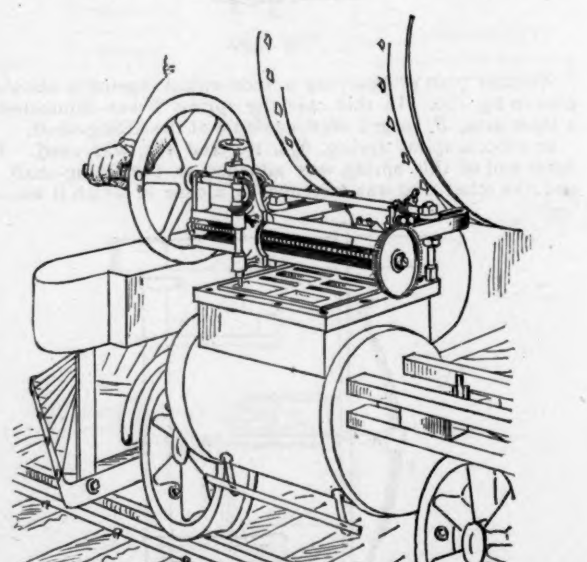


Fig. 11.

STEAM-CHEST SEAT MILLING MACHINE.

chuck on the end next to the wheel, upon which there is no wear, being then clamped in position by two bent or U-clamps to the spokes of the wheel or driver. A triangular feed-casing contains gears, worms and worm-wheels; these admit of feed-

ing either way, as the operator may desire. Tools of various shapes can be made to suit different shaped collars.

The machine, shown by fig. 14, is used for removing the hard adhering crust of lime from the outside surface of boiler flues, which is very difficult to remove in a cleaning roller or tumbler, and expensive as well, because of the waste of steam and time. A laborer operates the machine, entering the flues one at a time; they are then revolved and fed through like a screw and drop off on opposite side without assistance. Very little power is required to run the machine. It will clean flues ranging from 1⅞ in. to 3½ in. diameter, removing all scale and without injury to the flue. It occupies but little room, is almost noiseless and makes but little dust. It is so constructed that no countershaft is required, being provided with a double clutch-gear, which enables it to be reversed in case of special need, which sets the pulley free. To set the machine, it is only necessary to place it in line with a pulley on the shaft from which power is taken.

Three revolving shafts, provided with circular, blunt-edged, steel cutters, are set obliquely in adjustable boxes, the central line of the flue passing between them; these boxes are connected with a movable ring, governed by a worm-screw, which is operated by the lower hand-wheel, and each of them is provided with a small, adjustable, circular, assisting cutter with cross teeth, which cuts the line lengthwise; after being cut crosswise by the circular cutting plates on revolving shafts, the scale is consequently reduced to square particles in a rough manner; the same process is repeated by four circular finishing cutters revolved by the flue, two of them being provided with longitudinal teeth, and two with cross teeth, and placed adjustable on the same inclined plane to the extending plate.

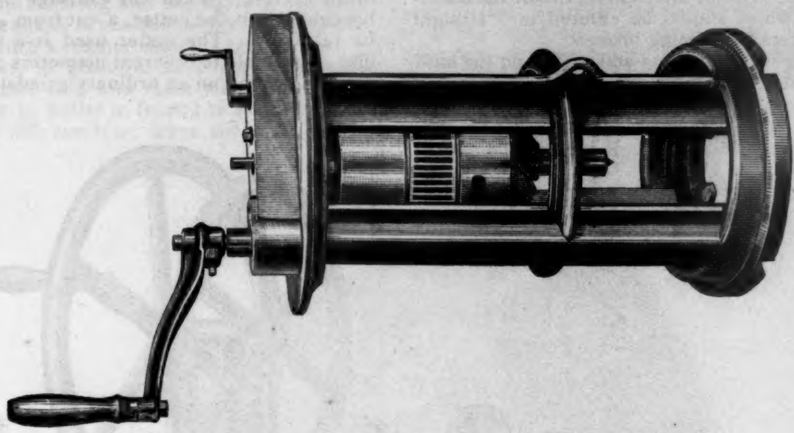


Fig. 12.

PORTABLE CRANK-PIN MACHINE.

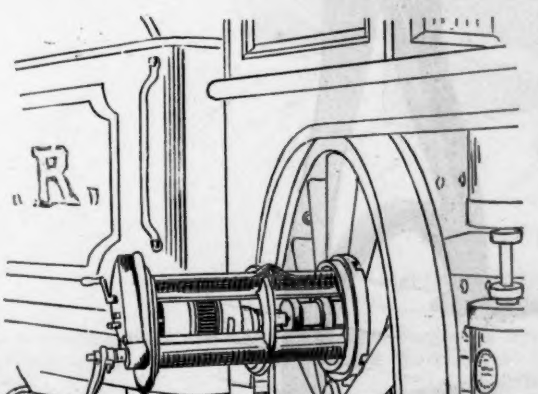


Fig. 13.

PORTABLE CRANK-PIN MACHINE.

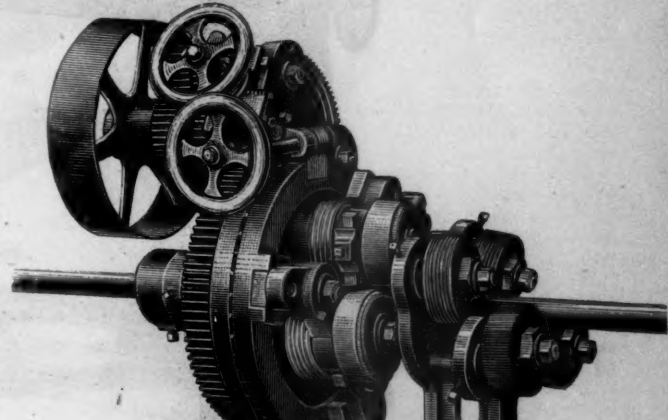


Fig. 14.

ATLAS FLUE-CLEANING MACHINE.

Having the circular cutters on the revolving shafts on the same inclined plane, the first and second cutters on each shaft will not come in contact with the flue but will afford an easy entrance, acting like a mill, preventing the machine from chocking; there is no sticking, as the cutters are all revolving. To overcome oval places or uneven diameters, the cutters are arranged to give a little, and, when passed, immediately come

back to the original position, and by a slight movement of the top hand-wheel, the machine can be reversed (or stopped) and the bad place cleaned by passing back and through again. Many flues are not perfectly straight, but as any part of them within the machine is held central in line, the projecting ends are at liberty to swing.

The entrance tube is provided with a set of collars with different sized holes to be inserted alternately, to suit the different diameters of flues, which should be entered in a straight line, to prevent the cutters from being broken.

This machine is strong in all its parts and will stand the hard work it is designed to do; the shafts are protected from dirt and dust with bronze bushings, which can be replaced; the cutters are best tool steel, and are made in duplicates, which can be furnished when desired. The platform of the frame is shaped like a saddle to allow the loose lime to fall off freely. The speed of the machine is optional with the user. The pulley can be run as high as 400 revolutions per minute, when about 6 ft. per minute will be cleaned. At 80 revolutions, it feeds and cleans, on 2-in. tubes, 2 ft. per minute.

In this age of heavy freight and fast passenger service, it is necessary that all the wearing parts of locomotives should be properly attended to and kept in the best kind of repair. The connecting rod and parallel brasses require considerable attention, and, when kept "brass and brass," as termed, fitting the crank-pins properly, there is very little noise and jar. The present manner of keeping them true by filing the faces requires a very expert man and consumes a great amount of time. It is necessary to have the joints or faces of the brasses exactly true with the straps, and, unless they are so when keyed up, they will wear the straps as well as the brasses and become loose, when straps and brasses both have to be replaced. Fig. 15 shows a jointer for facing locomotive brasses, designed to do this particular kind of work by hand or power; it is made so light that two men can carry it to the work. It has an adjustable chuck that catches the brasses, same as the strap does, and holds them, as held on the pin. No more time is required to accurately catch or place the brass in it, than to screw up an ordinary rise. When the carriage containing the chuck is brought up to the cutter, a cut from $\frac{1}{1000}$ to ⅛ of an inch can be taken off. The cutter used is a single one, placed in a disc adjustable to different diameters; it can be quickly taken out and ground on an ordinary grindstone or emery wheel.

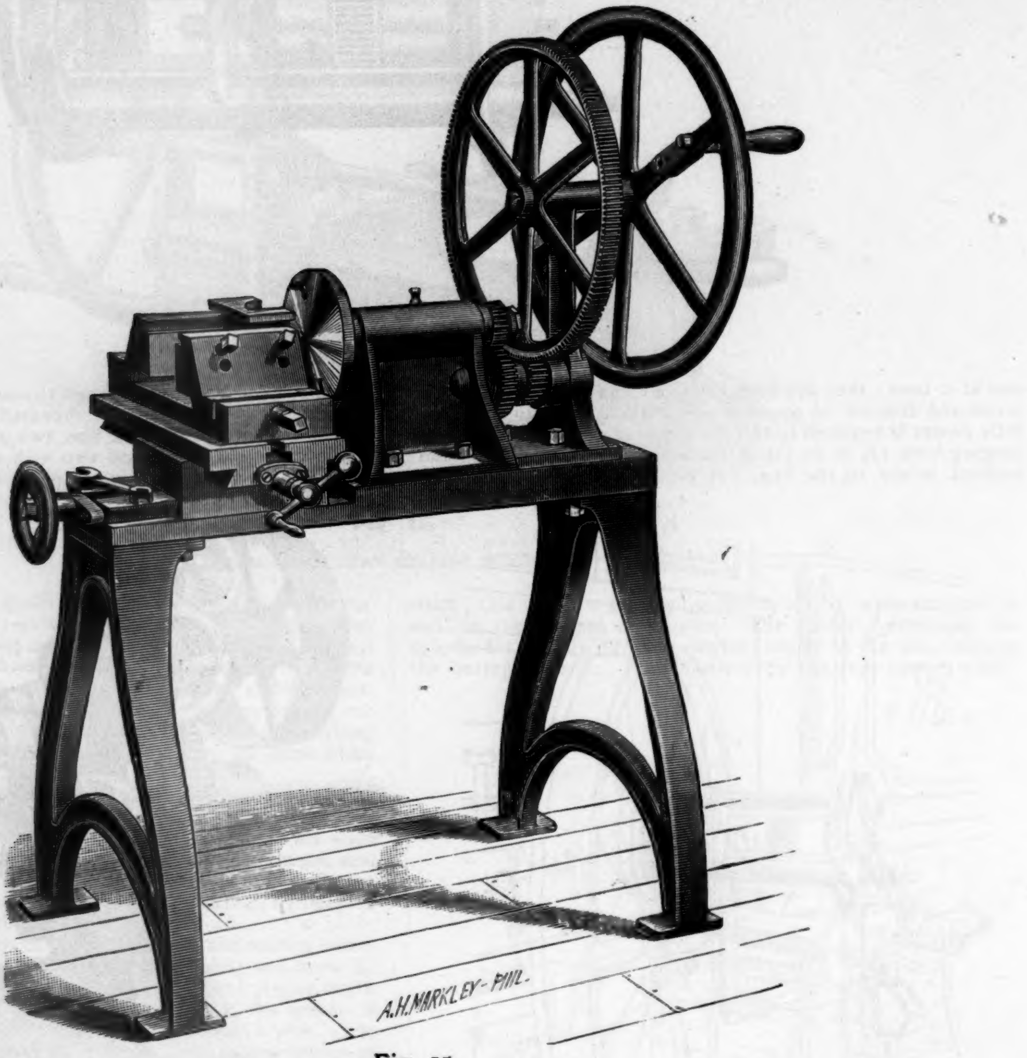


Fig. 15.

JOINTER FOR FACING LOCOMOTIVE BRASSES.

The machine shown in fig. 16 is designed for drilling all the holes in smoke-boxes and cylinder flanges necessary to hang one pair of cylinders, and at one setting of the machine, no previous drilling being necessary. It can be driven by hand or belt power, the latter being preferable for rapid work. It consists of an adjustable, triangular spider at one end, so arranged that by screwing on or off the pointed ends, the center of the machine is central with the smoke-box. This spider supports one end of the machine, the other end being supported by a cross-head, held in position by dogs that clamp firmly to outer edge of the smoke-box.

On this cross head, sliding pieces are arranged to slip to or from the center for different diameters; these sliding pieces have holes in them to hold the dogs and allow for different lengths of smoke-boxes. The drilling-head slides on two parallel rods, on which it can be shifted for any hole to be drilled. These rods are in line with center of smoke-box, and between them is the driving shaft having a bevel gear-wheel fastened to it to drive spindle of the drill, the other end passes through the hub of

driving-pulley, having a key in it working into a spline of the shaft; the drilling head also swings on a bearing, central between the two parallel rods. It requires very little time to set the machine, and, when once set, all the holes can be drilled and reamed parallel and concentric; it need not be stopped to shift from one hole to another, as the shifting is done by sliding the drilling head in or out and swinging from one side to the other. The machine is strong and will carry a 1⅜ drill without any difficulty; the shank is reamed to take more twist-drill taper shanks, into which a reamer shank is fitted.

After the cylinders are in position, an expert man with helper can set the machine, drill and ream all the holes required to bolt the cylinder to boiler in from 4 to 5 hours; this same work, *done without this machine*, takes about 2½ days' time.

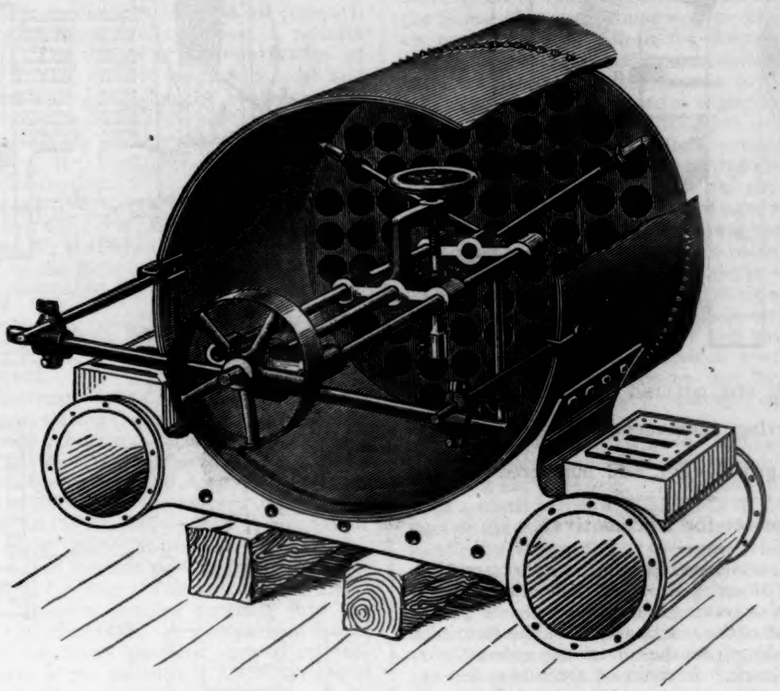


Fig. 16.

RIEPPEL'S PORTABLE DRILLING MACHINE.

The above machines are made by Messrs. Pedrick & Ayer, proprietors of the L. B. Flanders Machine Works, of Philadelphia.

Manufacturing Notes.

THE Lappin Brake Shoe Company, has started up its new works at Bloomfield, N. J., and has already began shipping to fill orders. The works are fitted with every modern improvement for turning out the product with economy and rapidity. The plant has a capacity of 25 tons a day.

The Philadelphia Gas Company has begun the building of extensive works in Pittsburgh for the manufacture of the fixtures, regulators, castings, etc., used in its business. These have heretofore been supplied by the Westinghouse Air Brake Company, but that Company's works are now fully occupied on brake work.

The Pratt & Whitney Company, in Hartford, Conn., is making 150 Gardner improved machine guns for the Italian Government.

The Sanderson Brothers Steel Company is rebuilding and enlarging its works at Syracuse, N. Y., which were recently damaged by fire.

The bridge works of the Chicago Forge & Bolt Company were destroyed by fire May 2. These works were built in 1869 by L. B. Boomer, and were owned successively by the American Bridge Company, Rust & Coolidge, and the present owners. They will be rebuilt.

The buildings of the Paterson Iron Company, at Paterson, N. J., were destroyed by fire May 12, the buildings being burned down and the machinery badly damaged. The Company had an extensive plant for heavy forgings and a rolling mill. The works are to be rebuilt.

The Grant Locomotive Works, of Paterson, N. J., recently shipped through Messrs. Russell & Co., of China, the first locomotive engine ever built in America for use in China. It goes to the Kaiping Railway Company, limited, which controls the Kaiping coal mines, about 75 miles northeast of Tien-tsin, in the province of Chih-li, and has a light railroad of standard gauge, 29 miles long, and used for hauling coal.

The first steel rails ever made in the South w[illegible] made at the new mill of the Roane Iron Company, in C[illegible]tanooga, Tenn., on May 7, last. The mill has now one 5-ton Bessemer converter in operation, and a second converter is to be put in.

Machine for Rolling Car-Wheels.

Theodore W. Bean, of Morisstown, Pa., has recently patented the machine illustrated viz the accompanying engraving, the purpose of which is "to produce car-wheels of rolled and compressed steel."

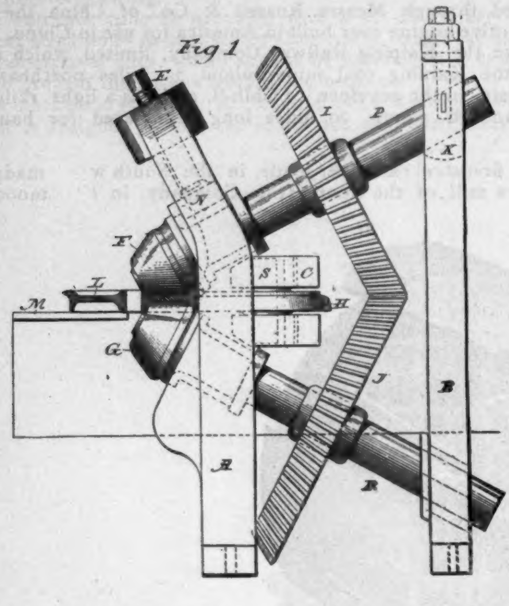
The engraving shows a side view of the machine, *F* and *G* are two roll-heads attached to shafts *R* and *P*. The roll-heads are so shaped as to give the desired form to the steel ingot, which is to be compressed by them into the exact size required.

H is another roll whose periphery give the shape to the thread of the wheel. It will be readily noticed that it moves by friction with the ingot, and is not actuated by either of the side rolls.

A and *B* are housings in which the shafts *P* and *R* are journaled. The ball-box *K* in the upper bearing, *B*, supports the extreme end of the shaft *P*, and its construction allows the roll-head at the other end to be raised or lowered while the bearing acts as a stationary pivot. The desired pressure on the roll-head *F* is given by means of the screw *E* on the rider *N* and allows the roll-heads to be separated sufficiently while the steel ingot is be placed between them on the table *M*.

Power is applied to the shaft *R*, which communicates its motive to *P* by the bevel gears *J* and *I*. The ingot of steel having been cast to a suitable shape and heated is placed in

position on the table *M* between the roll-heads. The screw *E* forces the rider *N* on to the roll *F*, and the steel ing t is pressed between it and the lower roll. The rolls *H* and *G* act as a die, while the upper roll gradually descends and com-



BEAN'S MACHINE FOR ROLLING CAR-WHEELS.

presses the metal, rendering it homogenous throughout and of greater tensile strength.

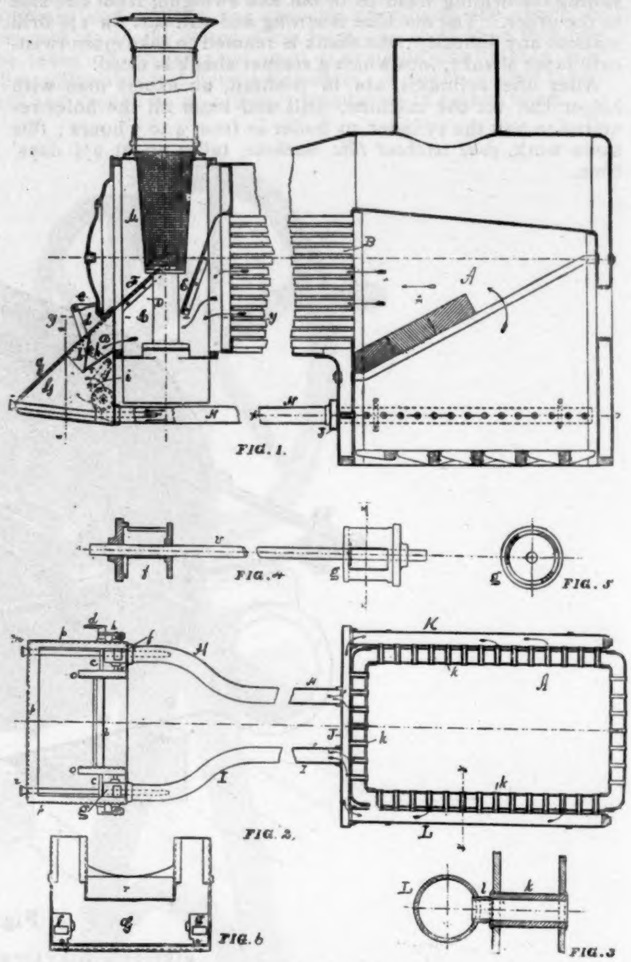
The patent is dated April 19, 1887, and numbered 361,479.

Spark-Arrester for Locomotives.

THE accompanying illustrations represent a spark-arrester, recently patented by William Wilson, of Bloomington, Ill. As will be seen from the engravings, a wire netting is placed in the smoke-box, instead of the stack, and is in the form of a frustum of a cone, extending from the top of the exhaust nozzle to the bottom of the stack. In front of the tubes, and extending below the top of the exhaust nozzle is a deflector *E*, and another deflector *F* is placed in front of and below the nozzle. Appended to the lower part of the smoke-box is a receptacle or spark-box *G*, the opening into which can be closed by a valve. From this spark-box two pipes, *H I*, run back to the fire-box, where they connect with the pipes *J K L*, running along the front and side of the fire-box, and having communications with it through the hollow stay-bolts *k k k k*; an enlarged section of the pipe and stay-bolt are shown in fig. 3. There are further provided two small pipes *m m*, opening in front of the spark-box into the air, and extending backward into and a short distance through the large pipes *H I*. The pipes *H I*, at their entrance into the spark-box, are provided with valves *f g*, and these valves are operated by a shaft extending through the spark-box and by a system of levers *d h*, which also moves the valve *b* between the smoke-box and the spark-box.

The operation is as follows: Suppose the valve *b* to be open and the valves *f g* to be closed, then sparks which pass through the flues will be deflected downward by the diaphragm or deflecting plate *E*, and, as they move very swiftly, they will be carried across through the smoke-arch and passage *a* into the spark-box *G*. The deflecting plate *F* will have a beneficial effect in aiding to prevent the upward movement of the sparks after they pass the lower end of the deflector *E*. When the spark-box is full or nearly so, the engineer through the rod *e*, can close the valve *b* and at the same time open the valves *f g*, and then communication between the smoke-arch and spark-box will be closed, and communication from the spark-box through the passage *H I* to the fire-box will be open. As often as the steam is exhausted air will be drawn through the flues from the fire-box, and at the same time air and the cinders in the spark-box will be drawn through the tubes *H I*, chamber *J*, tubes *K L*, and hollow stay-bolts *k* into the fire-box, to take the place of the air drawn therefrom by the action of the exhaust-steam. At the same time a current of air will pass through the pipes *m m* into the passages *H I*, and a strong current of air will pass through the passages *H I*, facilitating the withdrawal of the cinders from the spark-box, and also furnishing pure air to the fire-box to promote combustion.

When the spark-box has been emptied, which can be done ordinarily in three or four minutes, the valves *f g* can be closed and the valve *b* be opened, when the operation will be



WILSON'S SPARK-ARRESTER.

repeated. The spark-box may have a capacity sufficient to hold, say, five or six bushels of cinders.

An opening may be provided in the bottom of the spark-box, through which cinders may be removed in case of any stoppage in the passages leading from the spark-box back to the fire-box. This opening, if provided, will of course be kept closed, except when opened for the purpose of removing cinders.

Mr. Wilson's patent is dated April 26, 1887, and is numbered 361,738.

Proceedings of Societies.

Engineers' Club of St. Louis.

A REGULAR meeting was held in St. Louis, April 20, President Potter in the chair; 16 members and 2 visitors present.

Mr. McMath, Chairman of the Committee on Resolutions on the death of Capt. J. B. Eads, submitted a report which, on vote, was received. It was directed that the report be spread upon the records of the Club, and a copy sent to the family of the deceased.

Prof. Johnson made a verbal report of the recent meeting of the Board of Managers of the Association of Engineering Societies at Chicago. The new arrangements made for the publication of the *Journal* were reported, and its regular appearance in future promised.

Mr. C. W. Clark then read a paper on Experiments with Submerged Adjutages, describing some experiments made at

the University of Illinois. He deduced the results, giving the co-efficient of discharge for each form of adjutage experimented with. The paper was discussed by Prof. Johnson, J. A. Seddon, Russell, Prof. Gale and R. E. McMath.

A paper by Col. E. D. Meier was announced for the next meeting.

THE Club met in St. Louis, May 4, President Potter in the chair, and 12 members present.

Col. E. D. Meier then read a paper on Evaporative Efficiency of Boilers, prefacing his remarks by the statement that he had been unable to complete his investigations, and asking that the present paper be considered as introductory to a more complete discussion which he hoped to be able to present later. Colonel Meier spoke of the duty expected of steam-generating apparatus, and the difficulties met with in reducing the results secured in tests to a common standard for comparison. Some suggestions were made looking toward a suitable standard of comparison. The values of various grades of fuels were touched upon. The relative merits of steel and iron for boiler construction were discussed, the conclusion being that it depended wholly upon proper precautions being taken to make sure that a suitable grade of material is secured. Prof. Potter, Prof. Johnson, Mr. Flad, Mr. Seddon and Mr. Wheeler took part in the discussion.

The President announced the Committee on Smoke Prevention, as now constituted, to be: W. B. Potter, E. D. Meier, H. B. Gale, C. F. White, W. H. Bryan and C. E. Jones. A paper by H. A. Wheeler on the Relative Economy of Machine and Hand-Drilling, was announced for the next meeting.

THE Club met May 18, President Potter in the chair, 21 members and 2 visitors present. J. N. Judson and N. W. Eayrs were elected members.

Mr. R. E. McMath, Chairman of the Committee on National Public Works, made a report stating that no recent progress had been made. On motion the report was received and the committee discharged. Mr. McMath was directed to remit to the Treasurer of the National Committee the funds in hand for that specific purpose and to express to the officers of that body the sentiment of the Club on the subject—which is not favorable to further agitation of the matter at present.

Mr. H. A. Wheeler then read a paper on The Relative Economy of Machine and Hand Drilling. The subject was carefully reviewed, and the various factors entering into the problem were explained and discussed. A comparison based upon results in St. Louis limestone quarries showed an economy of 20 per cent. in favor of the machine. A comparison of work at the Conglomerate Mine showed, in drifting, 5 per cent. in favor of the machine, but in sinking, hand work showed a superiority of 20 per cent. The comparisons were made upon the relative cost per foot of hole drilled, and did not include the factors of quantity of material removed, speed required and ventilation. The value of each of these factors could only be determined by an investigation into the special requirements of each case. They should always receive attention as they have an important bearing on the problem.

The discussion was participated in by Messrs. Holman, Melcher, Seddon, Moore, Potter and Stockett.

The question of the relative cost of mining coal by machine and by hand was also brought up. It was stated by Mr. Stockett that he had accumulated data showing 15 to 20 per cent. economy in favor of the machine. The principal advantage of machine work was its effect on the labor question.

Boston Society of Civil Engineers.

THE Boston Society of Civil Engineers held its regular monthly meeting at its rooms in Boston, May 18, with 43 members and 9 visitors present. Mr. S. E. Tinkham was elected Secretary in place of H. L. Eaton, resigned.

Mr. P. H. Dudley read a long and carefully prepared paper on Woods, their Structure, Decay and Preservation. This was followed by a short discussion, and the Club then adjourned.

Engineers' Club of Kansas City.

AT the regular meeting in Kansas City, Mo., May 2, official notice was received that the Club had been admitted into the Association of Engineering Societies. Messrs. Wm. D. Jenkins, J. F. Wallace, Robert C. Pearsons, M. E. Bowen, E. W. Grant, Wm. Norris and T. F. Wynne were elected members. Mr. Galen W. Pearsons, Chief Engineer of the National Water Works Company, read the paper of the evening, entitled Work with Submarine Armor.

Mr. William H. Breithaupt, consulting engineer, of the firm of Breithaupt & Allen, presented lithographs of the longest continuous girder-bridge yet constructed, at Lachine, Quebec.

Engineers' Club of Philadelphia.

A REGULAR meeting was held in the Club rooms in Philadelphia, President T. M. Cleemann in the chair; 24 members present.

The Secretary presented, for Mr. Edwin Ludlow, Notes on the Preparation of Anthracite Coal. Mr. Ludlow says:

"I desire to call the attention of the members of this Club, and especially those who are mechanical engineers and have the bump of inventiveness well developed, to one of the greatest needs now met with in the preparation of anthracite coal. While engineering ability and mechanical skill have done wonders during the last decade toward putting the mining and preparation of coal on a scientific basis, making it possible to ship as high as 2,600 tons of prepared coal from one breaker in a single day, still in every breaker, no matter how modern it may be, one will find the chutes, through which the coal passes from the screens to the loading-pockets, lined with boys from 12 to 14 years of age, who sit there 10 hours a day, picking by hand the slate from the coal as it passes along. The atmosphere of this screen-room is, in many cases, so laden with fine coal-dust that objects cannot be distinguished 20 ft. away; and while the breathing of this coal-dust does not seem to have any immediate effect on the boys' health, it undoubtedly lays the seeds for the bane of the coal region—miners' consumption. It strikes every thoughtful man, who looks down on from 100 to 200 boys working in a single breaker, that it is a very crude and expensive way of preparing coal.

"Various appliances have, of course, been designed, but the only really successful one, as proved by actual experience, has been the water-jig. This undoubtedly removes the slate with a small percentage of waste of coal, and where the product of the mine is wet, and water has to be used on the screens to effect a separation of the dirt from the coal, it is the best and most economical appliance that can be employed. But the greater part of the coal going to market comes from dry mines, where it would be a detriment to the quality of the coal, and a great expense, to use water.

"The waste-water from the jig is also expensive to take care of, as in most localities it is no longer allowable to let it run, with the fine dirt it holds in solution, into the nearest creek, as the sediment will carry a long distance, and invariably deposits itself where it will do the most harm, and entail a heavy suit for damages. Enough tanks have therefore to be provided to allow all the waste-water to thoroughly settle, so that the water and culm can be removed separately. Water itself, or rather the pure article, is both scarce and expensive during a part of each year throughout nearly the whole region.

"And if mine-water is used, as is generally the case, the acid contained in it attacks the iron-work of the jig, and makes frequent repairs necessary.

"The principle the jig works on is based on the difference in specific gravity between coal and slate. The two enter the bottom of the jig together, and, by the pulsations of a large plunger in an adjoining compartment, water is forced up through the coal, lifting it, and allowing a fresh supply to come in. The coal is forced to the top and runs off with the water, while the slate, owing to its greater specific gravity, passes out through a separate opening in the bottom.

"Now, what is needed, and what I hope some member of this Club will devise, is a dry jig, in which this separation will be effected by the use of air instead of water.

"One of the difficulties encountered in getting up such a jig is caused by the care with which coal has to be handled to prevent its chipping or breaking. It cannot be dropped on to iron or wire, or to itself, without producing an appreciable percentage of waste. With the most approved rolls the loss in re-breaking any size to a smaller one amounts to from 10 to 15 per cent.

"While the difference in specific gravity between coal and slate of the same sized pieces is very great, still trouble would be experienced in any separation by an air current with flat pieces of both slate and coal, on which the action of the air would vary, according to whether it acted on the edge or the whole side.

"The man who invents a successful dry jig that will stand the test of actual trial, will undoubtedly make a very handsome thing by it.

"Not to be too cumbersome, a single jig should not have a greater capacity than 500 tons per day, and as the shipping capacity of the anthracite region is about 200,000 tons per day, it would take about 400 to supply the trade.

"I shall always be most happy to furnish any information, or give any assistance in my power to any one desiring to work on the matter."

Mr. J. E. Codman presented a description of a Perpetual Motion Machine, which had been offered by a western correspondent of the Philadelphia Water Department, as a means of supplying Philadelphia with water at an annual running expense of $5 only.

A REGULAR meeting was held at the Club House in Philadelphia, May 7, President T. M. Cleemann in the chair; 19 members present.

The Secretary presented an illustrated paper by Mr. Lewis N. Lukens upon Some Remarkable Breaks in a Reservoir.

Captain S. C. McCorkle exhibited a map of the rivers in the vicinity of New York, made for commercial purposes, and referred to the proposed preparation of a similar map of the rivers in the vicinity of Philadelphia, requesting the discussion of the subject by the Club

It was suggested that the Schuylkill River above Fairmount Dam be included in the survey and plan, as a great convenience to some 1,500 members of the Philadelphia rowing fraternity, but Capt. McCorkle stated that the Government work could not be extended above tidewater.

It was also suggested that it would make the map more generally useful if the streets and other topography were extended across the city or farther inland, instead of, as in the New York map, only showing the wharves, piers and other waterfront lines.

The discussion was adjourned and its further continuance is invited.

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, May 4, President Worthen in the chair. The following elections were announced: *Members.*—Richard Milford Berrian, Chief Engineer Atlantic Coast, St. Johns & Indian River Railroad, New York City; John Sterling Deans, Phœnix Bridge Company, Phœnixville, Pa.; John Addison Fulton, Chicago, Santa Fe & California Railroad, Kansas City, Mo.; Wilbur Francis Goodrich, Toledo, St. Louis & Kansas City Railroad, Kokomo, Ind.; John Rogers Hudson, Pomona, Cal.; Frank Adolph Leers, Passaic Rolling Mill, Paterson, N. J.; John George Macklin, Grand Trunk Railway, Peterboro, Ont.; David Lowber Smith, Deputy Commissioner Department of Public Works, New York City. *Associate.*—Robert James Pratt, Electric Manufacturing Co., Troy, N. Y. *Juniors.*—Edgar Bonaparte Gosling, Department of Docks, New York City; Alfred Milton Mosscrop, Cornell University, Ithaca, N. Y.; Edward Walter Rathbun, Napanee, Tamworth & Quebec Railway, Napanee, Can.; William Plumb Williams, Assistant Engineer Electrical Subway Commission, New York City.

An abstract of a paper by Professor George F. Swain, Massachusetts Institute of Technology, on the Calculation of the Stresses in Bridges for the Actual Concentrated Loads, was read.

A paper was read by J. A. Monroe on a Novel Method of Removing Air from a Vertical Bend in a Suction Pipe. The method described in the paper was the application of a steam-injector to the top of the bend by a direct pipe from the boiler in such a manner as to exhaust the air. By reversing the direction of the steam it could also be used in cold weather to melt any ice forming in the bend.

A discussion took place also on certain questions connected with the testing of cements and the removal or prevention of the efflorescence on walls. As to the latter, Mr. Worthen mentioned the application on brick walls of the soap and alum solutions. Two or three applications of each, externally, caused no discoloration, and absolutely prevented all efflorescence.

A curious case of cement-testing was mentioned by Secretary Bogart, in which a cement showed greater strength at all the ages of mixture, thus far tested, when mixed one of cement to one of sand than when mixed neat.

A CIRCULAR from the Committee of Arrangements gives the following information in relation to the annual convention:

"The convention of 1887 will be held at the Hotel Kaaterskill, New York, beginning about July 2, 1887. The Kaaterskill is one of the largest hotels in the United States. It overlooks many miles of the course of the Hudson River. It is reached directly by rail from Rondout and Kingston, and also by rail from Catskill to the foot of the mountain, and thence by carriage to the hotel. It is contemplated that all those intending to be at the convention should, if possible, meet in New York City, and leave by steamboat on the morning of the day previous to the opening of the convention. The trip up the Hudson will be one of the features of this occasion. A stop will probably be made at West Point, and the works at the bridge over the Hudson at Poughkeepsie will be visited and inspected. The masonry and foundation of the piers and the superstructure of this bridge are in progress. The convention will continue at the hotel several days, including the Fourth of July. Arrangements are contemplated for a visit to the cement rock mines and the cement works of the Rondout Valley (Rosendale), which are near the Kaatersdill. The rate at the hotel will be $3 per day. Ample accommodations are assured. The details of arrangements for the convention, and for transit to and from the place, will be announced in a future circular.

"Members are invited to discuss the subjects presented by the papers which have been published in the transactions since the last convention. In addition to the papers already issued, the following will be ready either in full or in abstract, and will be sent to such members as will notify the committee of their willingness to discuss the subjects presented. Formulas for the Weights of Bridges, A. J. Du Bois; Vibration of Bridges, S. W. Robinson; Specifications for Strength of Bridges, J. A. L. Waddell; Calculations of the Strain in Bridges for the Actual Loads, G. F. Swain; Water Supply, Drainage and Sewerage of the Lawrenceville School, F. S. Odell; Determination of the Size of Sewers, R. E. McMath; Anchor Ice, James B. Francis; Steel, its Properties, its Use in Structures and in Heavy Guns, William Metcalf; Some Constants of Structural Steel, P. C. Rickets; Irrigation, Edward Bates Dorsey; Brick Industry near New York, Calvin Tomkins.

"It is expected that the following subjects, most of them suggested by some of the papers published or received during the past year, will be particularly discussed, and communications upon these subjects are especially invited by the committee.

"The inspection and maintenance of railway structures; the disposal of sewerage; recent practice in cable railway propulsion.

"Members of the society are particularly invited by the Committee to transmit their contributions at as early a date as possible, so that suitable arrangements may be made for the disposition of time at the convention. To insure the preparation and preliminary printing of papers or abstracts of papers to be presented at the convention, they must be received at the Society House not later than May 31.

"It is not intended to restrict in any sense the presentation of papers to the subjects above suggested."

A REGULAR meeting was held in New York, May 18.

The Secretary read a paper by Professor A. J. DuBois, giving Rational Formulæ for Weight of Bridges. The writer supported his formulæ (which will be found on another page) by elaborate mathematical reasoning, and supplemented them by tables calculated according to the formulæ.

Written discussions by Messrs. Seaman, Gottlieb, C. J. Morse, H. C. Jennings, E. Thatcher, Hughes, Pegram, Professors Waddell and Ricketts, were read; also a supplementary article, to close the discussion, by Professor DuBois. There was a short verbal discussion by Messrs. Thomson and C. E. Emery.

The Secretary announced that the party for the annual convention would leave New York on the Albany day boat, July 1. otherwise arrangements would be as heretofore announced.

The Secretary also stated that he would like to receive address of engineers competent to take charge of location and construction of sections or subdivisions of road.

A photograph of the new Manhattan Bridge over the Harlem River was presented by W. R. Hutton. A large piece of sandstone, scaled from Trinity Church, New York, showing marked effects of weather, was exhibited by a member.

New England Railroad Club.

THE regular meeting of this Club was held in Boston, May 11, President Lauder in the chair. The regular subject for the evening—Axle Bearings, Dust Guards and Lubrication was taken up.

The President opened the discussion by referring to the importance of dust guards, stating that in his opinion almost

all of the wear of journals is produced by foreign matter getting into the box. He showed a journal which had run 36,000 miles on a very dirty road without appreciable wear.

The discussion was continued by Messrs. Chamberlin, Coney, Morse, McKenzie, Adams, Hills and Gohring. Several speakers advocated the use of lead-lined boxes, while others preferred good bronze. The general opinion was expressed that with the weights of cars now in use the M. C. B. standard axle was, if anything, too small, and the President thought that 4 x 8 in. journals would soon be necessary.

After the end of the discussion, the Club adjourned until the second Wednesday in September.

Master Car-Builders' Club.

THE regular meeting was held at the rooms in New York, May 19. The meeting was devoted to the discussion of the Rules Governing the Interchange of Cars. The Club then adjourned until September.

Western Railway Club.

THE regular monthly meeting was held in Chicago, April 20. In the absence of President Scott, Mr. L. E. Johnson occupied the chair.

It was ordered that, as President Scott wished to retire from the Committee on Car Heating, the other two members of the committee be empowered to select the third member, in Mr. Scott's place.

Mr. Crossman, for the Chairman of the Committee, read a report of the Library Committee, which was, on motion, laid over until the September meeting.

Mr. Johnson, Chairmain of the Committee on Interchange Rules, presented a report recommending certain amendments. The report was taken up for discussion and action, but was not completed.

Under Rule 3, Sec. b, Mr. Meade presented a blue-print plan for a gauge differing from the plan given in the present rule in that it gives a definite point for the height of the vertical side of the flange when worn sharp; the leg being also lengthened ¼ in. in order to insert it in a worn tread next to flange. The adoption of this plan of gauge was recommended to the Master Car-Builders' Association.

The Club then adjourned until the third Wednesday of September.

Union Pacific Railway Club.

THIS Club was recently organized at Omaha, Neb., with the following officers: President, John Wilson; Active Vice-President, G. T. Crandell; Honorary Vice-Presidents, S. R. Callaway, G. M. Cumming, T. L. Kimball, S. T. Smith, Erastus Young; Secretary, Charles A. Starr; Treasurer, C. H. Ledlie; Librarian, Walter Carter; Directors, E. Buckingham, C. N. Pratt, H. B. Hodges, G. H. Mumford, George Weigman.

The Club will have rooms in the Headquarters Building of the company in Omaha, where regular meetings will be held on the third Saturday of each month for discussion of subjects connected with railroad operation. About 150 volumes have been secured as a nucleus for a library, which it is hoped to make an extensive one.

All employés of the Union Pacific Railway are eligible to membership in the Club, which has the support of the officers of the Company.

United States Naval Institute.

A MEETING of the Newport Branch was held at the Torpedo Station, Newport, R. I., April 27, to discuss a paper by Passed Assistant Engineer W. M. Parks on Training of Enlisted Men on the Engineers' Force. The author held that it would be far better for the boys when, they enlisted on board the *Minnesota*, to be placed at once in the engine and fire-rooms on that ship and trained to be first-class firemen and machinists, and if this was done the rank of second-class firemen could be abolished.

Captain Arthur R. Yates said that a great deal is involved, especially of time and expense, in training people for the engineers' department, either as firemen or machinists, and I think it would be of great benefit to the service if they could be trained on boaad our training squadron as they will then get a certain amount of military training before going aboard cruising ships.

Lieutenant Edwin K. Moore thought a better plan would be to have the apprentices sent aboard the training ships, and, when qualified for transfer, sent to some school for their apprenticeship as firemen, machinists or whatever capacity they may get in the future in the engineer corps. The boy should receive some training on board a ship before he is capable of doing anything on that ship: to take proper care of himself, his clothes, his hammock, his bag—and a certain amount of seamanship. He would require no more instruction, except in the one profession which he might select for the future. Then, if he could be sent to a steamship and serve a term of apprenticeship he thought it would be better than to take him as a green boy from the street or farm, or whatever place he may come from.

Lieutenant Joseph B. Murdock said that, in the abstract, he fully approved of this paper. He thought that the great necessity of the service to-day is for a higher technical training. Take our new ships. We require something more than ordinary steamships in handling them.

Ensign Geo. W. Denfield said that, according to his recollection, the system of training boys for the engineers' force has been tried and has been given up, one reason for which was that it had a tendency to ruin them physically. He did not think any man should be taken into the engine-room or fire-room until he had reached full growth. The hardships there, which men must endure, cannot be undertaken by boys. If you know what kind of a man you want, an examination will soon show whether he is qualified for the duties he is intended to perform. He was in favor of men being trained on shipboard, but thought they should have a certain amount of knowledge and training which men get on shore. He did not believe in training apprentices, but did believe in training men, in giving them some general idea of what is required of them before going on sea-going ships.

Commander F. J. Higginson said he could not help approving this system of educating. Let the apprentices go into the fire-room on the new cruisers and let them be taught their duties there, and then go into the machine-shops and learn the duties of the machinist.

Lieutenant Karl Rohrer thought the better educated the firemen and shovelers are, the less coal will be burned for the given amount of power. It was a question in his mind whether the fire-room offers sufficient attraction to draw a number of these boys into it after they have almost qualified themselves as seamen. He would take people between 18 and 23 years of age. He did not see why a system of apprenticeship could not be inaugurated to embrace all our naval stations, where boilers and machinery are in constant use, and there train these men in the manipulating of machinery, boilers, tools, etc., and then after three months, draft them on board our sea-going vessels.

Car Accountants' Association.

THIS Association held its twelfth annual convention in Atlanta, Ga., April 19, the sessions continuing on April 20 and 21.

The following officers were chosen: President, T. J. Hoyle; Vice-President, E. C. Spaulding; Secretary, H. H. Lyon; Treasurer, E. M. Horton; Executive Committee, W. A. Moody, G. J. Cook, W. G. Watson.

It was voted to change the name of the organization to the "International Association of Car Accountants," and it was decided to hold the next annual meeting in Montreal, Can., on the third Tuesday in June, 1888.

The time of the convention was taken up by discussions (and reading of papers and committee reports), on Reporting Switched Cars on Interchange Reports; Uniform System of Carding and Routing Foreign Cars; Reporting Destruction of Cars to Owners; Individual Mileage of Cars; Marking Line Cars.

On the last-named subject it was decided not to interfere with the Master Car-Builders' action.

The most important action of the convention was the adoption of a report in favor of abolishing the present rate of ¾ cent per mile for cars, and substituting for it a new rate as follows: ½ cent per mile and 15 cents per day; four-wheel cars one-half that amount. *Per diem* charge to commence on the date of delivery, and no *per diem* charge on cars received and delivered the same day. Line cars not subject to *per diem*, excepting on roads not on the line. *Per diem* not allowed on cars belonging to private car companies. The adoption of a junction report to owners of foreign cars.

A committee was appointed to present this action to the general managers and secure their approval. This action

makes a radical change in the system of charges for use of freight cars.

The convention was largely attended, and much interest was taken in the discussion.

American Institute of Electrical Engineers.

THE fourth annual meeting of this Institute was held in New York, May 3. At the first session, routine business was disposed of and the following officers elected: President, T. C. Martin; Vice-Presidents, Norvin Green, W. A. Anthony, Geo. C. Maynard, Frank L. Pope, R. R. Hazzard and E. Thompson; Secretary, Ralph W. Pope; Treasurer, Geo. M. Phelps.

A second session for discussion and reading of papers was held May 4. It was opened by an address from President Martin. Papers were read by Prof. E. Thompson, on Novel Phenomena of Alternating Currents; E. P. Roberts, on Practical Experience with Storage Batteries; J. H. Powers, on the Insulation of Arc Lighting Plants; Professor W. A. Anthony, on the Differing Diametrical Coefficients of Different Coils of a Fine Rheostat, and on the Change from Negative to Positive of the Temporary Coefficients of some Carbon Flames; D. C. Jackson, on the Best Ratio of the Section of the Gramme Armature to the Section of the Field Magnets; David Brooks, on Lead Encased Conductors.

A resolution was adopted directing the Council to take up the subject of permanent quarters and to proceed at once to solicit subscriptions.

Baltimore & Ohio Employes' Relief Association.

THE report of this Association for the year ending September 30 last shows that the total receipts for the year were $305,547, and the payments, $262,059; the cash balance at close of year was $184,157. The benefits paid to members during the year, and for the 6½ years from the foundation of the Association, were:

	1886 No.	1886 Amount.	1880-86 No.	1880-86 Amount.
Deaths from Accident	58	$ 61,000	307	$ 318,025
Deaths from Natural Causes	103	44,381	621	202,611
Disablements from Accident	2,864	39,116	14,840	193,520
Disablements from Sickness	4,906	73,206	29,342	430,079
Surgical Expenses	1,649	10,990	9,497	63,989
Total	9,580	$ 228,694	54,607	$ 1,208,224

The average payment for accidental death has been $1,036; for natural death, $326; for accidental injury, $13; for sickness, $15; surgical expenses, $7. The report says:

"The active membership on this date is 20,297; showing an increase, as compared with the previous year, of 4,001. The total number of certificates of membership issued since the inauguration of the Association (May 1, 1880) is 59,107; of which 8,414 were issued during the past year. This increase is due to the opening of the Philadelphia Division, and the insuring of the employés necessary to the operation of that division and to the increase of force employed by the company on its other divisions.

"The medical examination of all persons employed by the company has been continued, as well as the examinations for sight, hearing and color-sense. The result shows that 13,316 were examined as to their physical condition during the year, of whom 986, or 7.44 per cent., were rejected as being unfit for performing the duties required of them. Of the 2,783 persons examined for sight, hearing and color-sense, 171, or 6.14 per cent., were rejected as being deficient to such a degree as to render them dangerous employés for train or other service requiring the use or observation of form or color-signals.

"The distribution of standard remedies inaugurated some years ago has been continued with decidedly beneficial results, they having been placed within the reach of all employés, and their value becoming more and more appreciated by the good results produced.

"The system of sanitary inspection has been kept up, and many improvements in directions affecting the health of your members have been made."

The Saving Fund and Building Feature reports that there were, on September 30, last, 936 depositors, having a total amount of $356,638 on deposit. The loans of the fund amount to $227,848. Most of this is on building loans to depositors and other employés, and is repaid in monthly installments. The savings fund assets amount to $379,576, of which the sum of $88,617 is in cash and $55,500 invested.

International Congress of Geologists.

AT a meeting of the American Committee held in Albany, N. Y., in April, a motion was adopted abolishing the Committee of the Whole and its officers, and intrusting the duty of preparing reports on the separate divisions of the geological column to eight reporters, who were thereupon unanimously elected. The following was adopted by the Committee:

"*Resolved*, That we recommend to American geologists the acceptance of the conclusions of the International Congress; said changes to be formulated at a subsequent meeting of the Committee; and it being understood that the Committee will present such additions as are deemed necessary by American geologists to the Congress of London in 1888."

The reporters named, with the assignment to each, are as follows:

Quaternary, Recent, Archæology: Major Powell, Director U. S. Geological Survey, Washington.

Cainozoic (Marine): Professor E. A. Smith, State Geologist, Tuscaloosa, Ala.

Cainozoic (Interior): Professor E. D. Cope, No. 2,102 Pine Street, Philadelphia.

Mesozoic: Professor George H. Cook, State Geologist, Rutger's College, New Brunswick, N. J.

Upper Palæozoic, Carbonic: Professor J. J. Stevenson, University of New York, New York City.

Upper Palæozoic, Devonic: Professor H. S. Williams, Cornell University, Ithaca, N. Y.

Lower Palæozoic: Professor N. H. Winchell, State Geologist, University of Minnesota, Minneapolis, Minn.

Archæan: Dr. Persifor Frazer, No. 201 South Fifth Street, Philadelphia.

Each of these gentlemen is to obtain, for his own subject, the completest possible information from all sources. They all, therefore, unite in soliciting coöperation, suggestions or advice from any of their professional brethren having convictions as to classification, nomenclature, coloration or any of the numerous subjects brought before the last, or likely to be discussed at the next Congress.

The Burlington Brake Tests.

THE second series of tests of freight-train brakes under the direction of the committee of the Master Car-Builders' Association began at Burlington, Ia., May 9. As in the first series of tests, the Chicago, Burlington & Quincy Railroad Company gave the use of its tracks and furnished a pilot to accompany each train, the brake company being required to furnish 50 cars with a locomotive and crew.

The members of the Committee present were G. W. Rhodes, John S. Lentz, Benjamin Welsh and D. H. Neale. There were also present representatives of all the brake companies and a large number of railroad officers and others interested in the trials.

The brakes on the ground at the opening of the tests were the Westinghouse, the Eames, the Carpenter and the Hanscom. The American and the Card brake trains were not quite ready.

The Carpenter and the Hanscom brakes were not in the former tests. The Westinghouse brake train had some improvements over that in use previously, and was also provided with a battery and wires for setting the brakes simultaneously. This electrical apparatus is covered by the Flad patents, now owned by the Westinghouse Company, and can be used or not as desired.

The Westinghouse and the Eames brakes are too well known to require further description here. The Carpenter brake is a straight air-brake, electricity being used to set the brakes, the electrical valve forming an essential part of the apparatus.

The Hanscom is also an air-brake; on this train no driver brake is used on the locomotive.

The Card electric and the American made their appearance late in the tests, but not too late to take full part in the tests.

The general programme laid down by the Committee, with the rules governing the tests, we have given heretofore. The programme has been carried out very much in the order prescribed.

The most notable feature in the tests has been the use of electricity for the purpose of causing the brakes throughout the train to be set simultaneously, or as nearly so as possible.

Mitis Castings.—Mitis castings in wrought-iron or steel are now being successfully manufactured by Messrs. Hansell & Co., at their works in Sheffield, England. The demand has been so great than an extension of the works is contemplated.

PERSONALS.

Mr. John A. Klunk is now Engineer of Water Works at Columbus, Ohio.

Mr. F. B. Hibbard is now Superintendent of the Wilmington & Northern Railroad.

Mr. L. S. Graves has been appointed Superintendent of the St. Louis & Chicago road.

Mr. T. S. Morehead has resigned his position as Chief Engineer of the Wilkesbarre & Western road.

Mr. I. M. DeVarona is engaged in preparing plans for the additional water supply of the City of Albany, N. Y.

Mr. George Bowers has been appointed City Engineer of Lowell, Mass. He has been Assistant for some time.

Mr. A. Gordon Jones has been appointed Superintendent of the Valley Division of the Baltimore & Ohio Railroad.

Mr. I. N. Wilbur has been appointed Master Mechanic of the Hannibal & St. Joseph Railroad at Brookfield, Missouri.

Mr. George Rice, of Philadelphia, has been appointed Constructing Engineer of the Pittsburgh Traction Company.

Mr. R. E. Evenson is appointed Superintendent of the Eastern Division of the New York & New England Railroad.

Mr. S. R. Callaway has resigned his position as Vice-President and General Manager of the Union Pacific Railway.

Mr. W. B. Landreth, of Schenectady, N. Y., has been appointed Engineer to the Sewer Commission of Amsterdam, N. Y.

Mr. James F. Goddard has been appointed General Manager of the Atchison, Topeka & Santa Fe and its controlled lines.

Mr. Robert Moore has been appointed Consulting Engineer of the St. Louis Bridge Company, in place of the late C. Shaler Smith.

Mr. Horace G. Holden has resigned his position as Superintendent of Water Works at Lowell, Mass., after eight years' service.

Mr. L. A. Bowers has resigned his position as Superintendent of the Wilmington & Northern Railroad after 17 years' service.

Mr. Walter F. Randall, of Walton, N. Y., is Chief Engineer of the projected Canastota, Morrisville & Southern Railroad.

Mr. J. G. Chamberlain has been appointed Manager of the Alabama & Tennessee Coal & Iron Company, at Sheffield, Alabama.

Mr. W. P. Savage has been appointed Superintendent of the Southwestern Division of the Central Railroad of Georgia.

Mr. Peyton Randolph has been appointed Assistant General Manager of the East Tennessee, Virginia & Georgia Railroad lines.

Mr. John J. Whalen is appointed Master Mechanic of the Philadelphia & Reading road, with charge of the shops in Reading, Pa.

Mr. J. H. Rankin has been appointed Master Car Builder of the Philadelphia & Reading Railroad with office at Reading, Pa.

Mr. W. B. Parsons, Jr., has been appointed General Manager and Chief Engineer of the Denver Railroad, Land & Coal Company, with office at Denver, Colorado.

Mr. A. A. Jackson is General Superintendent of the New York & New England Railroad, succeeding Mr. William M. Turner, resigned.

Mr. Elliot Holbrook, recently with the New York & New England, has been appointed Chief Engineer of the Pittsburgh & Lake Erie road.

Mr. L. D. Ricketts, late of Leadville, Col., has been appointed Geologist for Wyoming Territory, and will have his office at Cheyenne.

Mr. C. P. Foote has been re-appointed Commissioner of Public Works of the City of Milwaukee, Wis., for another term of three years.

Mr. C. H. Hudson is appointed General Superintendent of the East Tennessee, Virginia & Georgia Railroad, with office in Knoxville, Tenn.

Mr. S. Fisher Morris, late Assistant Engineer on the new Croton Acqueduct, has been appointed Engineer in charge of the Fourth Division.

Mr. Isaac V. Baker, Jr., has been finally confirmed by the Senate as Railroad Commissioner of New York, to succeed Mr. John O'Donnell.

Mr. W. E. Rogers, after a long delay, has been finally confirmed as Railroad Commissioner of New York, thus beginning his second term.

Mr. George S. Allen is appointed Master Mechanic of the Philadelphia & Reading Railroad, with charge of the shops Northern, of Port Clinton.

Mr. Frank D. Moore is now Chief Engineer of the new bridge over the Missouri at Omaha, Neb. He was assistant to the late C. Shaler Smith.

Mr. Charles Pugsley has resigned his position as Chief Assistant Engineer to the Croton Aqueduct Commission, New York, on account of ill health.

Mr. E. A. Van Horne has resigned his position as General Superintendent of the Eastern Division of the Rome, Watertown & Ogdensburg Railroad.

Mr. John S. Kennedy, late with the Pennsylvania Steel Company, has been appointed Manager of the Pulaski Iron Company's Works at Pulaski, Va.

Captain Charles C. Morrison, U. S. A., has been relieved from duty at the Watertown Arsenal and ordered to duty with the Ordnance Board at New York.

Captain John E. Greer, U. S. A., has been ordered to New York to duty as a member of the Ordnance Board and the board for testing rifled cannon.

Mr. W. E. Chamberlain has been appointed Superintendent of the Harlem River Branch of the New York, New Haven & Hartford road. This is a new office.

Mr. A. J. Cromwell is appointed Superintendent of Motive Power for all lines of the Baltimore & Ohio Railroad east of the Ohio River, with office in Baltimore.

Mr. A. G. Kleinbeck, heretofore Superintendent of the St. Louis & Chicago Railroad, is now engineer in charge of the construction of the extension of the road.

Mr. W. H. Harrison has been appointed Superintendent of Motive Power of the Trans-Ohio Divisions of the Baltimore & Ohio Railroad, with office at Newark, Ohio.

Mr. David Lee has been appointed Superintendent of Maintenance of Way of the Trans-Ohio Divisions of the Baltimore & Ohio Railroad, with office at Newark, Ohio.

Mr. A. Hunter Johnson is appointed Engineer of Maintenance of Way of all lines of the Baltimore & Ohio east of the Ohio River. He has his office in Baltimore.

Mr. E. G. Allen, late of the New York & New England, has been appointed Superintendent of the Shore Line Division of the New York, New Haven & Hartford road.

Professor S. P. Langley has been chosen Secretary of the Smithsonian Institute at Washington. He is now connected with the Western University of Pennsylvania.

Mr. Elliott Holbrook is now Chief Engineer of the Pittsburgh & Lake Erie Railroad. He was recently Division Superintendent of the New York & New England.

Mr. E. B. Thomas, General Manager of the Richmond & Danville Railroad, has been appointed General Manager of the East Tennessee, Virginia & Georgia lines also.

Mr. S. T. Smith, for several years past General Superintendent of the Union Pacific, has been appointed General Manager of the Denver & Rio Grande Railway.

Mr. J. F. Holloway, formerly President of the Cuyahoga Steam Furnace Company, of Cleveland, O., has accepted a position with Henry R. Worthington in New York.

Mr. John E. Gleason has been appointed Master Mechanic in charge of the Keyser and Piedmont shops of the Baltimore & Ohio Railroad, in place of Samuel Houston, deceased.

Lieutenant W. H. Jaques has tendered his resignation to the Secretary of the Navy. He will, it is understood, accept an important position with the Bethlehem Iron Company.

Mr. Francis Collingwood has been appointed Chief Engineer of the Chesapeake Dry Dock & Construction Company at Newport News, Va. He will retain his office in New York.

Mr. L. H, Clark, for 10 years past Chief Engineer of the Lake Shore & Michigan Southern, has resigned that position, but will retain a connection with the road as Consulting Engineer.

M. James C. Clarke has finally resigned his position as President of the Illinois Central Company, on account of continued ill health. His successor is Mr. Stuyvesant Fish, late Vice-President.

Mr. Levi Hege, late Superintendent of Road Department of the Louisville & Nashville, has been appointed Superintendent of the Central Railroad of Georgia, in place of F. M. Fonda, deceased.

Mr. C. W. Smith, heretofore Vice-President and General Manager of the Atchison, Topeka & Santa Fe, is now Vice-President only, the duties of the two offices having become too heavy for one man.

Mr. G. W. Cushing, who recently resigned his position as Superintendent of Motive Power of the Northern Pacific, has taken charge of the mechanical department of the Philadelphia & Reading Railroad.

Colonel E. T. D. Myers is now General Superintendent of the Petersburg and the Richmond & Petersburg railroads, as well as of the Richmond, Fredericksburg & Potomac Railroad, with office at Richmond, Va.

Mr. James W. Hill, for nine years past Manager of the mechanical and water works department of Fairbanks & Co., St. Louis, has just resigned his position to become Master Mechanic of the Peoria & Pekin Railroad.

Mr. Harvey Middleton has been appointed Superintendent of Machinery of the Louisville & Nashville Railroad in place of Mr. Reuben Wells, who has gone to the Rogers Locomotive Works. Mr. Middleton was Mr. Wells' assistant.

Captain Charles W. Whipple, U. S. A., heretofore on duty with the Ordnance Board in New York, has been ordered to Leavenworth, Kan., where he will relieve Captain John E. Greer as Chief Ordnance Officer, Department of the Missouri.

Mr. T. R. Hardy has been appointed Chief Engineer of the Lake Shore & Michigan Southern, in place of Mr. L. H. Clark. Mr. Hardy was formerly Chief Engineer of the Boston & Albany, and went to the Lake Shore road in June last as assistant to Mr. Clark.

Mr. Bradford Dunham, late General Manager of the Baltimore & Ohio Railroad, has removed to Montgomery, Ala. He recently became Superintendent of the Capital City Street Railway & Highland Park Company, of Montgomery, but has since purchased on his own account the Montgomery Street Railroad, the consideration being $10,000.

Morison & Corthell is the title of a new firm formed on May 1 to do business as consulting and constructing engineers of bridges, railroads, and river and harbor works in the United States and other countries; to make examinations, reports, plans, specifications and estimates for bridges, and take active charge of their construction; to direct the construction of railroads, or, as experts, examine new routes or proposed branches of existing railroads; to examine, report upon and take charge of river and harbor improvement work for corporations or governments.

The new firm will have its offices at No. 35 Wall Street, New York, and 205 La Salle Street, Chicago. The members—Messrs. George S. Morison and E. L. Corthell—are widely known as engineers of high standing.

Mr. Corthell will retain his position as Chief Engineer of the Atlantic & Pacific Ship Railway.

NOTES AND NEWS.

Elevated Railroads in Cincinnati.—The Cincinnati & Suburban Railroad Company has made application for permission to build an elevated railroad from Fifth and Walnut Streets in Cincinnati, to the city line. The distance is 9 miles and the stations are to be about half a mile apart.

Missouri River Bridges.—Two large bridges are now under erection over the Missouri River, one at Randolph, Mo., for the Chicago, Milwaukee & St. Paul road, and one at Sibley for the Chicavo, Santa Fe & California road. Both of these will be high bridges, 60 ft. above low water mark.

Tunnel at Kansas City.—The Inter-State Railroad Company is building a tunnel about 1,500 ft. long in Kansas City, underneath West Eighth Street. The tunnel will enable the company to extend its tracks into the business center of the city, and make a new connection with the manufacturing district of the city.

Westinghouse Brakes on the Baltimore & Ohio.—The Baltimore & Ohio Railroad Company has closed a contract with the Westinghouse Air Brake Company for the equipment of all its passenger rolling stock with the Westinghouse automatic brake. The Baltimore & Ohio has heretofore used the Loughridge brake chiefly.

New Lake Steamer.—The *Roswell P. Flower* was recently launched from the yard of Wolf & Davidson, at Milwaukee, Wis. The *Flower* is 285 ft. long over all, 38 ft. beam and 22 ft. depth of hold, and has a carrying capacity of 2,400 tons. In addition to her engines she has considerable sailing capacity, and has four masts with fore-and-aft rig.

Pennsylvania Railroad Improvements.—The Pennsylvania Railroad Company will issue $8,000,000 new stock at par, for the purpose of providing for additions to property needed during the current year. The money is to be used as follows: Third and fourth tracks and additional facilities for business, $4,000,000; real estate, $700,000; new branch and auxiliary lines, $2,000,000; new locomotives and passenger equipment, $1,300,000.

New York Elevated Lines.—The Rapid Transit Commissioners have approved the building of lines along the water front by the Manhattan Company as branches of the present elevated system in New York. On the East River side they approved the line asked for, but on the North River side they have allowed a much shorter line than the company desired, turning off from the river at Duane Street and not reaching any of the uptown ferries.

Grade Crossings in Connecticut.—The Legislature of Connecticut has agreed upon a bill for the removal of grade railway crossings. It requires 250 of the more dangerous to be removed at the rate of at least 2 per cent. and not over 10 per cent. a year. The railroads must pay at least 40 per cent. of the cost, and 3 per cent. additional for each 1 per cent. of dividend paid, so that a road paying 10 per cent. dividend would pay 70 per cent. of the cost of the work. The State is to pay the rest.

Ohio Tinplate.—The *Bulletin* of the American Iron and Steel Association says: "The first sheet of tinplate ever made in Ohio was sucessfully manufactured at the Hubbard Tinning Company's works, at Hubbard, on April 10. It has been erroneously stated that this was the first sheet of tinplate ever made in the United States. Tinplates were made between 1873 and 1878 at Wellsville, Ohio, and at Leechburgh and Demmler, Pennsylvania. At these works the black sheets were both manufactured and tinned. The Hubbard enterprise consists simply in tinning imported black sheets."

A Large Shearing Machine.—The Pusey & Jones Company in Wilmington, Del., is making a shearing machine for cutting hot steel blooms for the Old Dominion Iron & Nail Works of Richmond, Va. The machine includes, beside the shears, a rolling table for carrying the blooms from the lifting table to the shears. The shears are thrown in and out of gear by a hydraulic cylinder. The whole machine is driven by an independent engine, with cylinder 8 in. diameter and 12 in. stroke. The shears will cut blooms up to 8 × 8 or by 5 × 15 in., and the whole machine weighs 40 tons.

Car Heating.—The Safety Car Heating & Lighting Company, of New York, has been organized to introduce a new system of heating cars devised by Mr. F. M. Wilder, who is General Manager of the Company. In this system steam from the locomotive passes through a drum under the car, and this drum is so arranged, that a simple connection can be made with hot water or hot air pipes of the heater systems now in use, the steam drum being simply substitnted for the old heater, which can remain in the car. The Company has a flexible coupling of new pattern for making connection between the cars.

Coating Iron with Lead.—Mr. Francis J. Clamer, of the Ajax Metal Company of Philadelphia, has discovered a method of depositing pure lead on iron, steel or other metallic surfaces by which, it is claimed, a perfect union of the metals can be secured. A great number of applications can be suggested for this process, as the lead will protect the iron or steel from rust, the action of acids, etc. Bridge rods and bolts can be thus protected, wires can be covered, and lead-coated iron sheets can be substituted for the lead sheets in the tanks used for making sulphuric acid and for other purposes.

Mr. Clamer has secured his discovery by patents in the United States, Canada and Europe. The Ajax Metal Company will soon be able to supply lead-coated articles to meet any demand.

New Use for Graphite.—The Joseph Dixon Crucible Company, of Jersey City, has introduced a new article called graphite smear-grease, intended to replace red lead in making joints for steam and gas fitting. It is made of properly pulverized and perfectly pure graphite, mixed with best boiled oil. The graphite being a natural lubricant it is claimed that it enables a fitter to make a much tighter and consequently a much more perfect joint. Further, that a joint so made can remain any length of time and will then yield to the ordinary pres-

sure of the tongs. It will make a better joint with less leakage, and render absolutely unnecessary the breaking of joints and couplings, and the straining of tongs. It is equally useful for bolts, screws, etc.

Tunneling the East River.—Last year the New York Legislature directed that certain officers of the New York and Brooklyn City governments should investigate and report this year upon the practicability of a new connection between the cities by bridge or tunnel at or near Grand Street, New York. The report has been made, and is to the effect that either a bridge over or a tunnel under the East River, at the point named, would be practicable, although more room would have to be allowed for the approaches than was specified in the resolutions of the Legislature. On the question whether the building of the connection was needed there was a sharp division, the New York officers all voting against, and the Brooklyn officials for it.

Electric Railroad in Orange.—The Orange Crosstown & Valley Railroad Company is now building a street railroad in Orange, N. J., to be operated by electricity. About half a mile of the line is completed and in operation. Overhead wires are used, power being furnished by a dynamo driven by a 12 H. P. engine at the terminus of the road. The Daft motor is used on the cars. The trolley that is used to take the current from the wires is of a special construction. Two wires are used, one of which is for the return current. The trolley has copper wheels that are insulated from each other, and which run upon the wires, taking the current from one, allowing it to pass down through the motor on the car and thence back through the opposite wheel and wire to the dynamo.

New Jersey Iron Mines.—The iron mines of New Jersey are now more generally employed than for some years past, The Wallace Mine, near Newfoundland, has been re-opened, and heavy shipments are made by Cooper & Hewitt who are working the mine. Cooper & Hewitt also bought, recently, the mines of the Manganese Iron Ore Company, at Sparta, in Sussex County. They are also working their mines at Green Pond and Charlotteburg.

The Bessemer Iron Ore Company, a new organization, is engaged in opening new mines at Oxford, in Warren County. The old Belvidere Mine in Warren County has also been re-opened, the water pumped out and the work of raising ore begun. The owners of this mine are building a railroad from the mine to the Lehigh & Hudson River Railroad.

Foreign Patents.—The United States has formally ratified and become a party to the "Convention of Nations for the Protection of Industrial Property," more briefly known as the International Industrial Union. This convention or treaty secures to citizens of the United States the privilege of obtaining valid patents in foreign countries any time within seven months after the patent has been granted here. Heretofore it has been necessary to obtain a patent in other countries on or before the day of its issue in this, in order to secure any protection against infringement. The same privilege is, of course, given by the United States to citizens of other countries in the Union. The countries of the Industrial Union are Belgium, Brazil, France, Great Britain, Guatemala, Holland, Norway, Portugal, Salvador, San Domingo, Servia, Spain, Sweden, Switzerland, Tunis and the United States.

Tunneling Boston Common.—The West End Land Company has submitted to the Boston City Council a plan for a tunnel or tunnels under the Common. The main tunnel proposed will cross the Common from Park Square to Merrimac Street, and the smaller tunnels will run from Beacon Street to Hamilton Place, and from Park Square to Park Street Church. The tunnels will be entirely covered and will not interfere with the surface of the Common, except for a short space at the entrances. The section proposed is 20 ft. wide and 16 ft. high, the arch springing from a point 6 ft. above the floor. Two tracks will be laid. The object of the tunnels is to afford routes for street-car lines to accommodate the Beacon Hill and Back Bay districts, and, by furnishing additional tracks, to relieve the annoying blockades now caused by the concentration of street-car lines on Tremont and Washington Streets.

Chicago, Burlington & Quincy Improvements.—Hereafter, as engines pass through the shops of this road for general repairs, they will be equipped with the extension smoke-box front and straight stack.

The Pullman Works at Pullman, Ill., are building 500 stock cars for the road.

In view of the constantly increasing fruit traffic, the shops at Aurora have begun building some cars to be placed in this special service, running them in passenger trains.

The dining-cars of the road are being fitted with a patent window-screen which, it is claimed, catches all dust and cinder of every kind.

Two of the car-shop's transfer-pits at Aurora are to be fitted with electric power transmission. The Yale & Towne Company, of Stamford, Conn,, and the Edison Electric Light Company, of Chicago, will supply the apparatus.

Copper-plated Steel Sheets.—The *Bulletin* of the American Iron & Steel Association says: "We have received a piece of sheet-steel from Mr. P. H. Laufman, of Pittsburgh, in a condition which indicates a new use for that metal. The sheet is made of decarbonized steel, and is manufactured at the Apollo Sheet-Iron Mills. After being rolled up to the proper thickness it is electroplated with copper on both sides and tinned on one side, and in this condition, it is contended by the manufacturers, it is a better article for many purposes than solid sheet-copper. Mr. P. H. Laufman has been experimenting in this work for years, and has protected his processes by patents. A company has been formed to manufacture the article, called the Pittsburgh Electro-Plating Company, whose office is at 543 Wood Street, Pittsburgh. Mr. P. H. Laufman is Chairman of the company, and Mr. James Benney, Jr., Secretary. The sheet-steel will be furnished to the company by Mr. Laufman's works at Apollo."

Standard Pipe-Threads.—The *Sanitary News* says: "Much has been said in technical journals concerning the necessity for the adoption of a uniform system of pipe-threads in the manufacture of pipe and fittings by different concerns in the country, so that all work would be interchangeable. It may be worthy of remark that the Briggs standard of pipe-threads, which all manufacturers have been urged to adopt, was adopted in 1862 by all the manufacturers of tubes in the United States. At that time Robert Briggs, C. E., was Superintendent of the Pascal Iron Works in Philadelphia, and the gauge he recommended was adopted. The only reason why complaint is now heard is because of the wear of gauges in different factories and the difference in personal equation in their preparation. The manufacturers have really wandered away from their standard adopted 24 years ago, and all that is needed to come back to it is the enforcement of a resolution to do so, which was passed at the meeting of the tube makers at Pittsburgh last October."

Railroad Accidents in Great Britain.—The Board of Trade returns give the number of persons killed and injured on railroads in the United Kingdom during the year 1886 as below:

	Killed.	Injured.	Total.
Passengers:			
In train accidents	8	615	623
Other ways (falling from trains, etc.)	87	727	814
Total passengers	95	1,342	1,437
Railroad Employés:			
In train accidents	4	81	85
Other ways (coupling cars, etc)	421	1,929	2,350
Total employés	425	2,010	2,435
Other persons:			
At highway crossings	81	25	106
Trespassers walking on track	285	91	376
Other causes	52	71	123
Total other persons	418	187	605

The total casualties of all classes include 938 killed and 3,539 hurt, against 957 killed and 3,467 injured in 1885.

A Natural-Gas Company.—The Philadelphia Company, the largest natural-gas company in the United States, reports that on March 31 last its total investment in plant was $8,245,966, of which $496,115 represented cost of gas wells, $1,106,680 charter franchises and patents, and $1,517,305, gas rights and leases; the remaining $5,125,866 being the cost of pipe lines, supplies, fixtures, etc. In addition to the fixed investment, the company had cash and other assets amounting to $615,100. The liabilities included $1,667,503 bills and accounts payable, $357,412, undivided profits, and, $6,336,150, capital stock. The chief items of the company's property were 381 acres owned in fee; 2,285 acres gas rights only owned; leases covering 53,612 acres; 411.87 miles of pipe lines and a number of buildings. The company's receipts for the year 1886, were $1,500,161; its working expenses, $355,900; interest and taxes, $186,276, a total of $542,176, leaving a net balance of $957,985. From this 12 per cent. dividends ($621,536) were paid, leaving an undivided balance of $336,449, equal to 5½ per cent. on the stock. Expenditures for new plant amounted to $1,198,657 for the year.

Large Steel Castings.—The Standard Steel Casting Company, whose works are at Thurlow, recently shipped to Messrs. Cramp & Sons, of Philadelphia, a steel stem-casting weighing 15,000 lbs. for a gunboat the latter firm are building for the United States Navy. There was also shipped from the same works a steel stem-casting weighing 13,000 lbs. The

Standard Company has also made for the same firm in Philadelphia 16 propeller-blades for the United States cruisers *Chicago*, *Boston* and *Atlanta*. The diameter of the wheel for the *Chicago* is 15½ ft., that of the wheels for the *Boston* and *Atlanta*, 17 ft. each. The weight of each propeller-blade for the *Chicago* is 2,410 lbs., and for the *Boston* and *Atlanta*, 3,750 lbs. each. The pitch of the wheels is 21, 24 and 24½, respectively. These blades were put to the following tests: They were bolted to a face-plate in a horizontal position, and 30,000 lbs. suspended from the tip-ends of the blades. When the blades were relieved from the weight, they sprang back to place, after a deflection of only $\frac{1}{32}$ in. The stem and stern pieces described are the first ones of cast-steel ever produced in the United States, all others having been forged.

The new St. Lawrence Bridge at Quebec.—The designs for the proposed railroad bridge across the St. Lawrence, at Quebec, have been prepared by Sir James Brunlees and Mr. A. L. Light, M. Inst. C. E., Government Engineer of the Province of Quebec. The St. Lawrence at the point selected is only 2,400 ft. from shore to shore; but, as the great depth of water prevents the construction of piers in the center, the cantilever principle has to be adopted tor the superstructure. Two massive piers of granite masonry will be built at a distance of 500 ft. and 240 ft. from the shores of the river in a depth of about 40 ft. of water, and on these the enormous cantilever ironwork will be erected. The piers will be built sufficiently high to allow the masts of the largest ocean steamers to pass under the center span. The dimensions of the bridge will be as follows:—Length of center cantilever span, 1,442 ft.; length of northern shore span, 487 ft.; length of southern shore span, 487 ft.; total length of bridge and approaches, 3,460 ft.; height from high-water mark to bottom of bridge, 150 ft.; height of piers above high water, 150 ft.; extreme height of top of cantilever above high water, 408 ft. The center span will be 290 ft. shorter than that of the Forth, which has a span of 1,730 ft.

The Cyclone Pulverizer.—A new pulverizer for grinding ores, rock, slag, etc., has recently been exhibited in New York. It is called the "cyclone," and its construction is based upon a principle long familiar to engineers; it consists of an iron drum, in the interior of which revolve in opposite directions, at a very high rate of speed, two hard steel fan-blowers attached to horizontal shafts.

The extremities of these blowers being several inches apart, leave a clear central space for receiving the rough material from a screw feed. The pulverization is effected by the violence and rapidity with which the particles are made to continuously collide or strike against each other, and by the action of the air currents produced by the revolutions, and regulated at will to any degree or intensity, through openings arranged in the drums.

In proportion as to the disintegration takes place from the friction, the resulting powder is drawn—in a state of fineness dependent entirely upon the volume of air admitted through the deflectors—into a series of adjoining chambers, where it is deposited according to its specific gravity; the heaviest in the first, the lighter in the second, the still lighter in the third, and the lightest in the fourth.

Prices of Iron and Steel.—The report of the American Iron & Steel Association gives an interesting table of prices of leading articles of iron and steel, monthly, for three years past. From it we take the following table:

	July, '84.	Jan., '85.	July, '85.	Jan., '86.	July, '86.	Jan., 87
Old iron rails at Phila	$ 18.50	$ 17.50	$ 17.25	$ 22.00	$ 19.00	$ 25.25
No. 1 foundry pig, Phila	20.00	18.00	17.75	18.50	18.25	21.50
Gray forge pig, Phila	18.00	16.00	15.00	16.25	16.90	18.50
Grav forge pig, Pittsburgh	17.00	16.25	15.00	16.30	15 75	20.50
Steel rails at Eastern Mills	30.00	27.00	27.25	34.50	34.50	38.50
Best bar (cents per lb.), Phila	2.00	1.80	1.80	1.85	1.90	2.15
Muck bar (cents per lb.), Pittsburgh	1.70	1.65	1.60	1.70	1.65	2.00
Iron nails (keg.), Pittsburgh	2.20	2.05	2.20	2.50	1.90	2.35

The prices given are the average for the month, and are for a ton of 2,240 lbs., except for bar-iron and nails, which are quoted by the pound and the keg.

With the advance in these prices, the price of iron ore has been put up about 30 per cent., while coke has advanced over 80 per cent.

The Bethelehem Iron Company.—Preparations are well advanced on the new steel plant of this company, which will be one of the best in the world. There is to be a 125-ton hammer, which alone will cost half a million dollars to build. The great hammer at Creusot, in France, is only 100 tons, and until within a short time Krupp's biggest hammer was 50 tons. In addition to the great hammer, the Bethlehem Works will have two of the largest hydraulic presses in the world for bending steel plates and forgings, and also a full set of mschinery manufactured by Whitworth for the compression of steel in a fluid state. One building, 600 ft. in length, to be made of steel and brick, is nearly completed, and other huge structures are on the way. The managers of the Bethlehem Company do not intend to depend upon the Government for maintenance. They believe that, as soon as their new works are in operation, they will have large commercial orders for steel shafting and heavy steel work which will keep them busy. Several millions of dollars are to be invested in the new work, and a combination has been effected with Schneider & Co., of Creusot, in France, by which the Bethelehem Company will have the advantage of the latest machinery and the skilled labor of the great French company in beginning the manufacture of war material on the largest scale in this country.

New Blast Furnaces and Steel Works.—The annual report of the American Iron & Steel Association gives the following lists of blast furnaces and steel plants completed since January 1, 1886, and under contract and building on March 1, 1887:

	Completed.	Building.
Blast Furnaces:		
Charcoal	4	4
Anthracite	.	3
Bituminous and Coke	3	32
Total	7	39
Steel Plants:		
Bessemer	7	9
Clapp-Griffiths	6	2
Open-hearth	9	6
Total	22	17

These tables do not include new furnaces built to replace old ones, or projected plants not actually under contract. The number of furnaces given is the number of stacks.

Of the blast furnaces building, no less than 20 are in Alabama; 5 are in Pennsylvania; 4 in Ohio; 3 in New York; 3 in Tennessee; 2 in Virginia; 1 in Kentucky and 1 in Wisconsin.

Of the new steel plants under contract, 8 are in Pennsyluania; 3 in Illinois; 2 in Indiana; 1 each in Massachusetts, Virginia, Tennessee and Ohio.

There are a number of new furnaces projected, chiefly in Alabama, which have not yet reached the contract point.

Profit Sharing on a Railroad.—A plan presented by President J. M. Ashley has been approved by the stockholders of the Toledo, Ann Arbor & North Michigan Railroad Company, and is to be tried on that road. Its object is to make the employés of the company sharers in its profits. All officials and employés, except the President, are to become beneficiaries of the plan after they have been in the employ of the road five years. In any year in which a dividend is declared each beneficiary is to receive, in addition to his salary, a dividend on the amount of that salary, the same as if he were the owner of that much stock. If any employé or officer is disabled while on duty, so as to be unable to resume his place for six months or more, he is to receive a certificate of paid-up stock equal in amount to the total sum of his wages for the year preceding his disability. In case of a loss of life in active duty, his wife or legal representative is to receive a similar certificate equivalent to five times his last year's wages. Every officer or employé who shall voluntarily retire from the company's service after 20 years' continuous employment, will receive a certificate of paid-up stock equal to the total wages of the last year of his service. This plan of allotment was adopted in the confident belief that it will largely increase the net earnings of the company and promote zeal, economy and general efficiency; that it will also prove itself to be a valuable educator, and teach the necessity of sobriety and fidelity.

Reporting Accidents in Ohio.—The Railroad Commissioner of Ohio has issued the following circular:

"This office is in receipt of a large number of letters requesting interpretations of section 257 of the Revised Statutes of Ohio, to which attention was called by circular letter of April 12.

"In reply to all such I desire to say that the intention of all law is to be operative, and that superintendents of railroads or other officers in charge must promptly notify, by telegraph, the Commissioner of all accidents happening on such railroad or the part of a railroad in this State resulting in the loss of life to any person or persons. 'All accidents' is a term so broad that it must be held to cover all accidents occurring upon

railroad property, whereby human lives are lost, irrespective of their respective causes, and also includes all accidents to persons employed by the railroad company.

"Hereafter reports must be made at once by telegraph, giving if possible the name and the residence of the persons killed. Weekly reports by mail will not suffice. Where it is found that telegraph reports first made did not contain the correct name or residence of the killed, subsequent reports of all information in possession of superintendents or managers must be forwarded by mail as early as possible.

"The State furnishes no blanks on which to make reports, but the information contemplated should give the name, place of residence, name of conductor, number of train and cause of accident, and also state if the person was an employé or not."

Lookout Mountain Inclined Railroad.—The inclined railroad up Lookout Mountain, near Chattanooga, Tenn., is now in full operation. The incline is 4,300 ft. long, rising in that distance about 1,200 ft. The grade varies from 1 in 3 to 1 in 6, the average being 1 in 3½. The track is narrow gauge, and consists of 25-pound steel rails laid on cedar ties and secured by heavy lag-screws, and is well ballasted with stone. There are two heavy curves in the line, but 2,500 ft. being straight. There are three rails in the track, thus making a double-track road. At the place where the up and down cars pass, a fourth rail becomes necessary, so as to make two independent tracks, on which the cars move alternately up and down. The passing points are operated, however, without movable switches.

The propulsion is by cable operated from the foot of the incline. The cable is of special steel, is 1 in. in diameter, with an estimated breaking strength of 50 tons, and a maximum strain of 5 tons. The speed of ascent is about seven miles per hour.

The cars are fitted with a shoe-brake, designed by Major King, operating on the principle so much used in mountainous regions for braking wagons. The brakes are always "on," unless held "off" by the conductor. There is also a system of electric signaling.

At the top of the incline a narrow-gauge line, 1¼ miles long, operated by a tank locomotive weighing 11 tons, takes the visitors to Sunset Rock in nine minutes. The total cost of the line was about $150,000.

The inclined plane and the railroad on the summit were built by a company which owns the land on the mountain and has laid out an extensive park there.

Brooklyn Bridge Improvements.—The Brooklyn Bridge Trustees have adopted a plan for the bridge terminus in New York that was submitted to them by Trustees Clarke and McDonald, which plan was prepared by Charles E. Emery, C. E., of New York.

The plan provides that the promenade shall be continued from the stairway at the New York anchorage by an iron trestle about 15 ft. above the level of the cable road, through the center of the bridge-house, to a platform from which the street can be reached by a double staircase. The promenade entrance will be about 36 ft. above the street, and about level with the top of the elevated railroad station. The present entrance to the promenade will have a broad stairway leading to a platform between the tracks, 19 ft. wide and about 350 ft. long, for the use of outgoing passengers. The parallel of the tracks inside the bridge-house will be continued only to the eastern side of Park Row, and the tracks across the street are to be removed to supply platform and stairway room.

The plan contemplates doing away with switch-engines entirely by putting in duplicate tracks and duplicate cables, one set of which will turn off from the north to the south track about 600 ft. east of the end of the road. Every alternate train will be run upon this track, and discharge its passengers upon the outside platform on the south side of the station. Trains on the other track are to run directly into the station as at present, and discharge their passengers upon the outside platform on the north side; both trains loading from the center platform, that on the south track will proceed directly across the bridge, while the other will cross to the south side by its own cable east of the station. By this scheme only one set of switches will be required.

An American "Bore-Hole."—A correspondent of *The* (London) *Engineer* seems to take it very seriously that the Newcastle Chemical Company, whose works are at Gateshead, has determined to put down a bore-hole for water by what is called the American process.

He says: "It is somewhat strange that in South Durham and North Yorkshire, where so many bore-holes have been made to obtain access to the great salt deposits, that we should be dependent on our transatlantic cousins for the best method of developing our own resources. It appears, however, that the large amount of attention given to boring, and the experience gained in the States in seeking for petroleum oil, has enabled the Americans to know how to operate more quickly and cheaply than we do on this side of the Atlantic. One is immediately struck, when inspecting a sinking on their system, with the extreme simplicity of the apparatus they use. The engine is a good one, though small, having usually only a 12-in. cylinder, and it is afterward retained for working the brine-pump. The boring-rod, which is some 50 ft. or 60 ft. long, in jointed sections, is also well made. All the rest of the machinery is as cheap and crude as it is possible to imagine, but it works well enough, and to make it more expensively would be quite unnecessary. There is only one man and one lad employed on each shift. These do the whole of the work. One shift starts at noon and the other at midnight. Boring by the diamond-drill does not seem to be able to compete at all with the American system, either as regards rapidity or cheapness. One of the chief characteristics of the latter is that, when the hole is complete, and the salt is reached, almost all the appliances are retained in their original position, as, in case of a breakage of the pumping-tube, they may be required again at any time. There seems little doubt but that since boring can be done so cheaply and so expeditiously, it may be usefully employed for many other purposes connected with mining and other branches of engineering."

The Basic Steel Patents.—The *Bulletin* of the American Iron and Steel Association says: "The opinion appears to prevail in some sections of the country that the production of basic steel in the United States has been prevented by the selfishness of the Bessemer Steel Company, Limited, which owns the English patents and has supposed that it also owned Mr. Reese's patents. It is true that, immediately after the Bessemer Steel Company, Limited, acquired the ownership of the English patents, it declined to grant licenses to use them, and for a variety of reasons not now necessary to inquire into or to justify. It is true, also, that, when the controversy with Mr. Reese commenced several years ago, no persons wanted to take licenses from the company unless they were guaranteed against an infringement lawsuit from the other side, which guarantee could not be given. It has thus happened that, down to this day the Bessemer Steel Company, Limited, has not granted a single license, although for several years it has been ready and willing to grant licenses to all persons who would agree to pay a royalty of $1.00 per ton for every ton of melted metal which should be converted into steel by the basic process. It has not advertised this fact because of the legal difficulties with Mr. Reese, which, as we have said, prevented it from guaranteeing possible licences against legal proceedings in Mr. Reesees behalf. But to various applicants it has explained the situation exactly as we have done above. The company is now willing to grant licenses upon the terms mentioned. It would be glad to get back in the shape of loyalties a part of the $300,000 it has paid for the English patents and paid to Mr. Reese, or agreed to pay to him.

"It will be seen that the real difficulty in the granting and accepting of licenses to use the basic process in this country has been an extended legal and troublesome controversy with Mr. Reese, against whom the Bessemer Steel Company, Limited, brought suit many years ago to compel the performance of the contract which it alleged it had made with him. This controversy is now in a fair way of being speedily ended. It is a curious fact that the original or acid Bessemer process was also several years getting a start in this country, owing to a vigorous controversy between two sets of gentlemen, each of which claimed to own the only patents under which Bessemer steel could be made."

Hydraulic Testing Machines.—The Yale & Towne Manufacturing Company, in 1882, acquired control of all the inventions and patents of A. H. Emery, C. E., relating to scales, gauges and testing-machines.

These machines were then already in high repute, by reason of the celebrity acquired by the 400 ton testing-machine designed and built by Mr. Emery for the Government, and located in the United States Arsenal at Watertown, Mass. The reputation thus established has been strengthened and enlarged by the experience acquired with other testing-machines on the Emery system.

Engineers acquainted with the principles of construction of the Emery testing-machines know that the building of these machines involves facilities for working pieces of large size and weight, and necessitates also the ability to manipulate these with a degree of precision and mechanical skill resembling in fineness that required in watch-making and rarely needed or attempted in connection with heavy work. Upon undertaking the building of these machines, the Yale &

Towne Company provided a suitable plant for the purpose, and have built some 10 machines, of capacities ranging from 60,000 up to 300,000 lbs. The plant and organization required for this work, however, is entirely special in this case, and does not harmonize with any of the several and varied classes of products which are manufactured in the works.

While the mechanical results of the business under this company's management have been excellent, the commercial results have, for the reason just stated, been less satisfactory. To remedy this, and at the same time provide for the proper continuance of the business, the company has concluded an agreement with Messrs. William Sellers & Company, Incorporated, of Philadelphia, under which that concern receives an exclusive license in the United States for the building of testing-machines on the Emery system, and have arranged to transfer also the drawings, patterns, special tools, etc., provided in this business.

The Yale & Towne Company retains several finished testing-machines, of 75 and 150 tons capacity, which are for sale. All other business in relation to testing-machines should be transacted with William Sellers & Company.

Natural Gas in the West.—The Cleveland *Iron Trade Review* says: "Whatever the skepticism of the past, there can be no longer any doubt that the district comprising Western Pennsylvania, Ohio, Indiana and adjacent territory is now the producer of the cheapest and most abundant fuel on the face of the globe. Nothing need be said of the magnitude of the natural-gas interest of Western Pennsylvania; the fact that the connections made last year in Pittsburgh by the Philadelphia Company alone aggregated 12,400, against 7,000 the previous year, shows to what proportions the use of the new fuel has grown.

"We have not at hand sufficient data to show the total daily production of gas-wells now flowing in the district above defined, but recent conservative estimates place the flow in the Northwestern Ohio District at not far from 100,000,000 cubic feet per day.

"Not less surprising has been the rapid development of natural-gas territory in Indiana during the past 60 or 90 days. While it cannot be admitted that the strike at Fairmount, Ind., heralded the past week as the 'largest gas-well in the world' is so, nevertheless its estimated flow of 12,000,000 cubic feet per day places it well up alongside the great Karg well of Ohio, and certainly beyond anything that Pennsylvania has yet produced. Other points in Indiana that have been proven to be within the high-pressure gas belt are Kokomo, Muncie, Marion, Noblesville, Mexico, Anderson and Indianapolis. What the next 60 days will bring forth is hard to conjecture.

"A curious thing in regard to the advent of the new fuel is the fact that, while it has displaced thousands of tons of coal in the districts directly within the gas belt, thefigures of production show that, instead of being materially reduced thereby, the output of coal in Western Pennsylvania and Ohio last year was very largely increased. During the first nine months of 1886, there was an increased coal output in the Pittsburgh District of nearly 140,000 tons as compared with the same period in 1886, while the Ohio output in 1886 was 500,000 tons in excess of 1885, aggregating 9,500,000 tons. This clearly shows that new markets have been found for the coal product more than sufficient to make up for the loss sustained to coal producers by the use of natural gas. Not only this, but the competition of the new fuel has resulted in greater economy in the use of coal; so that, even should the supply of gas be diminished, or fail, the cheaper use of coal is assured for all time to come."

Electric Lighting of Cars.—For nearly two months the Connecticut River Railroad has been running a train brilliantly illuminated by electricity supplied by a dynamo which is run by the car wheels. The train consists of two passenger coaches and a combination baggage and smoking car. The dynamo occupies a closet built on one side of the baggage section of the car next the entrance to the smoking apartment. There 16 incandescent lamps of 16-candle power to a car, arranged on each side, and differ from those on the Boston & Albany train in the construction of the film, which is of carbonized silk, instead of bamboo fiber. Attached to the journal at one end of the car is a 12-in. section pulley, over which an iron cable revolves, running a counter shaft, on a slight elevation above, 30 ft. away, by a 16-in. pulley. The cable is 65 ft. long, ½ in. in thickness, and made up of 132 wire strands. Iron rollers suspended from the car draw up the lower and press down on the upper halves of the cable, guiding it and keeping it taut. The cable runs directly in the center of the car, while the belt to the dynamo above is attached to a 36-in. pulley near the outside. This pulley surrounds a 12-in. friction wheel, two shoes grasping it firmly by means of two double springs. Here an ingenious device regulates the speed. As soon as the speed comes up, block governors near the circumference of the swiftly moving wheel fly apart, and with a lever and cam movement the shoes are released from the friction wheel, reducing the speed of the 36-in. wheel surrounding to the required amount. The dynamo is of 5 H. P. and 50-light capacity. From the supply wires leading to the lamps, special wires are stretched off to the storage battery on the opposite side and balancing the car. This battery is of the Julien system, has 24 cells and a storage capacity of 45 volts, being able to light one 16-candle power incandescent lamp 160 ampere hours. When fully charged, it is expected to light 3 cars at least 2 hours. Indicators on the storage boxes and at the dynamo record the voltage of each. When the train is running at full speed an excess of electricity is constantly running to the storage cells, to be ready for service when the station is reached and the wheels stop running. The experiment of utilizing the car wheels for running a dynamo is being conducted by Mr. S. H. Barrett, electrician, and as an economical and practical method of lighting cars by electricity, he is very hopeful for the future of his machine. The entire outfit for fitting up three cars will cost but $600, and the only expense will be in the wear and to replace the incandescent lamps. For lighting three cars the machinery and plant only weighs about 1,000 pounds, and if the battery is doubled for 5 cars it would weigh less than a ton, while on the Boston & Albany Railroad the storage batteries for each car weigh a ton.—*Boston Herald.*

The New Naval Vessels.—The good work of rehabilitating the Navy is slowly progressing. The first frame of the *Baltimore* was raised May 20, and the Messrs. Cramp report the arrival of plenty of material to carry on the work without interruption on both that vessel and Gunboat No. 1. The first carload of material for the *Charleston* arrived at San Francisco last week, and her contractors expect to go on with the work of construction without delay. The Columbia Iron Works of Baltimore, are making good headway in getting out the material for Gunboat No. 2, and will be able to begin work of construction very soon.

At the Navy Department Mr. Whitney is stirring things up to get the plans, specifications, blank forms of proposals and contracts ready for the bidders on the *Newark*, two 19-knot cruisers and two 1,700 ton gunboats. The bids for the construction of these vessels are not to be opened until August 1, but according to the Department's circular the plans, etc., were to be ready for the inspection of bidders by June 1. It is a little doubtful whether this promise can be kept, but the work is being pushed with all possible speed. Chief Constructor Wilson is working with an extra force of draftsmen upon the plans for the hulls, and with the valuable assistance of Naval Constructor Hichborn is making good headway with the detailed specifications. Colonel Remey's office, in addition to its other multifarious duties, is preparing the blank form of proposal and contracts. The plants for the machinery of these vessels are being prepared under the direction of Chief Engineer Melville at Cramp's Works in Philadelphia. Several assistants and draftsmen have been placed at his service and he has been directed to employ all the additional force necessary to give the plans out by June 1. As he only received the instructions last week some lively work will have to be done during the next ten days if the Secretary's wish is to be complied with. The plans of the gunboats, however, will be simply copies of those upon which the machinery of Gunboat No. 1 is being built, and the plans for the 19-knot cruisers will be, practically, duplicates of the *Baltimore's* machinery. The plans of the hulls of the two gunboats by Chief Constructor Wilson are also copies of Gunboat No. 1, now building.

The hulls of the 19-knot cruisers will be similar in design to the *Newark*. The plans and specifications for the hull and machinery of the latter vessel have been practically completed by the Bureau of Construction and Repair and the Bureau of Steam Engineering. The latter bureau is now engaged upon the plans for the machinery of the 6,000-ton armored vessels.

The Board, Captain Ramsay, President, appointed to examine plans for these vessels have agreed upon a report and await notice from the Secretary of the Navy to present it. What they have agreed upon cannot be definitely learned, but it is rumored around the Navy Department that they failed to agree and that the Secretary has declined to receive the report until he can submit certain advice which may force them to arrive at a satisfactory conclusion. It is well known that there was considerable diversity of opinion among members of the Board before they convened the last time, and now that there is so much mystery connected with their report, there would seem to be good reason for suspecting that an unanimous conclusion was not reached.—*Army and Navy Journal.*